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ABSTRACT

This Unified Sciences and Mathematics for Elementary Schools (USMES) unit challenges students to find ways to overcome difficulties in getting from one place to another. The challenge is general enough to apply to many problem-solving situations in mathematics, science, social science, and language arts at any elementary school level (grades 1-8). The Teacher Resource Book for the unit is divided into five sections. Section I describes the USMES approach to student-initiated investigations of real problems, including a discussion of the nature of USMES "challenges." Section II provides an overview of possible student activities with comments on prerequisite skills, instructional strategies, suggestions when using the unit with primary grades, a flow chart illustrating how investigations evolve from students' discussions of problems, and a hypothetical account of primary-level class activities. Section III provides documented events of actual class activities from kindergarten and grades 1, 5, and 6. Section IV includes lists of "How To" cards and background papers, bibliography of non-USMES materials, and a glossary. Section V consists of charts identifying skills, concepts, processes, and areas of study learned as students become involved with the activities. (JN)

ED220308

USMES

Getting There

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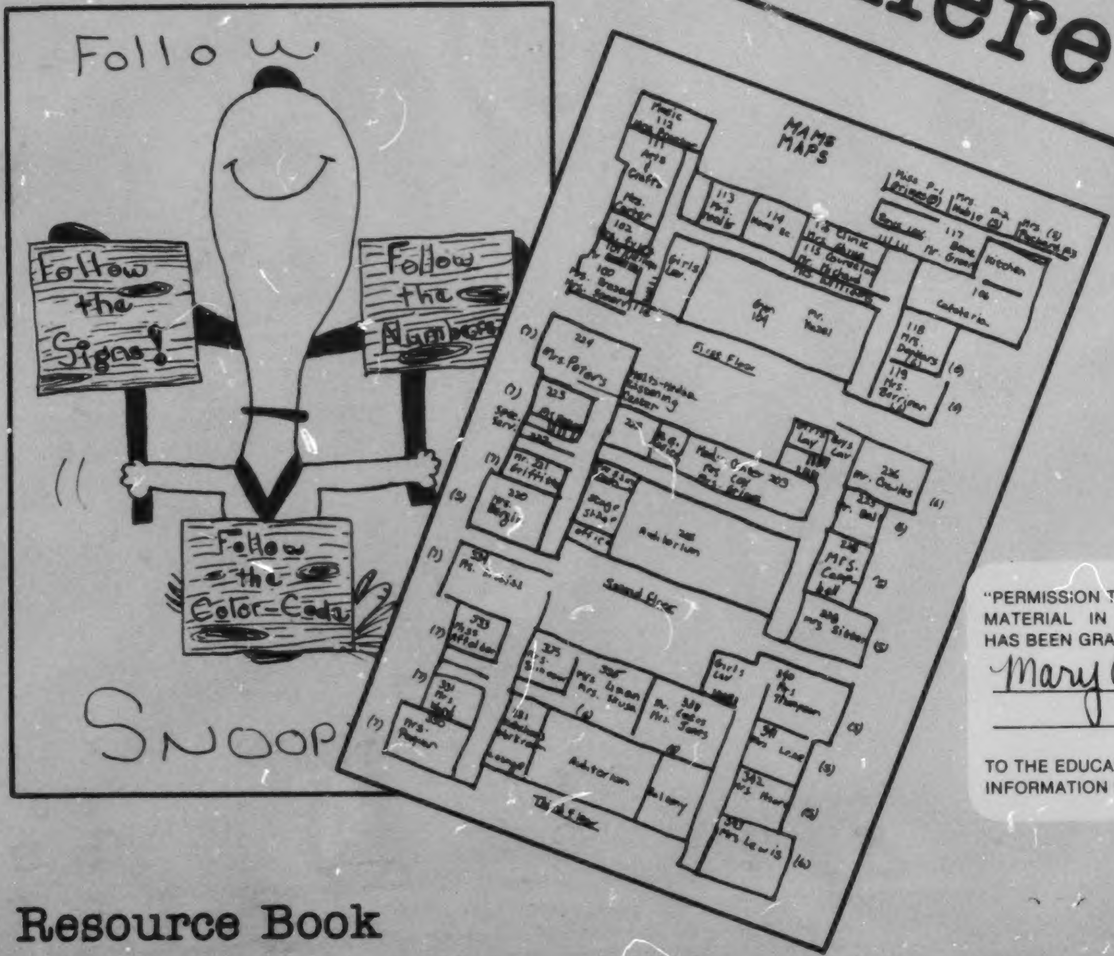
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Teacher Resource Book

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This book is a resource developed by the USMES Project; Earle L. Lomon, Project Director; Betty M. Beck, Associate Director for Development; Thomas L. Brown, Associate Director for Utilization Studies; Quinton E. Baker, Associate Director for Administration.

UNIFIED SCIENCES AND MATHEMATICS FOR ELEMENTARY SCHOOLS:
Mathematics and the Natural, Social, and Communications Sciences in
Real Problem Solving.

Getting There

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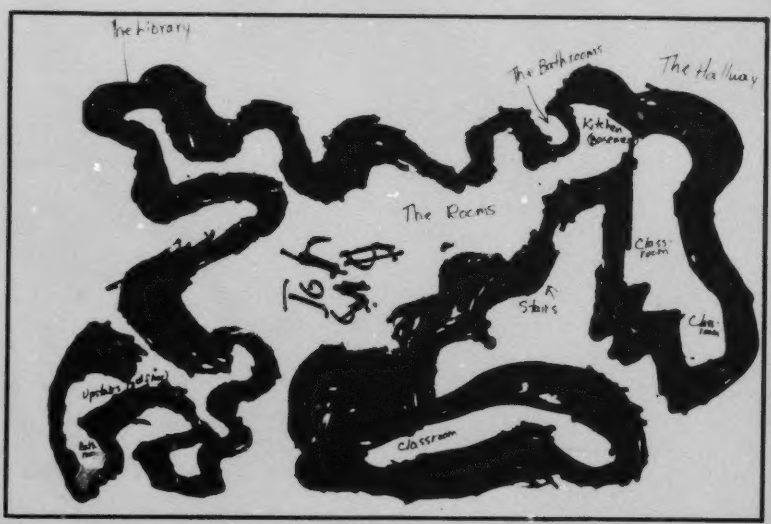
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CHALLENGE: FIND WAYS TO OVERCOME THE DIFFICULTIES IN GETTING FROM ONE PLACE TO ANOTHER.

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Preface

The USMES Project

Unified Sciences and Mathematics for Elementary Schools: Mathematics and the Natural, Social, and Communications Sciences in Real Problem Solving (USMES) was formed in response to the recommendations of the 1967 Cambridge Conference on the Correlation of Science and Mathematics in the Schools.* Since its inception in 1970, USMES has been funded by the National Science Foundation to develop and carry out field trials of interdisciplinary units centered on long-range investigations of real and practical problems (or "challenges") taken from the local school/community environment. School planners can use these units to design a flexible curriculum for grades kindergarten through eight in which real problem solving plays an important role.

Development and field trials were carried out by teachers and students in the classroom with the assistance of university specialists at workshops and at occasional other meetings. The work was coordinated by a staff at the Education Development Center in Newton, Massachusetts. In addition, the staff at EDC coordinated implementation programs involving schools, districts, and colleges that are carrying out local USMES implementation programs for teachers and schools in their area.

Trial editions of the following units are currently available:

- Advertising
- Bicycle Transportation
- Classroom Design
- Classroom Management
- Consumer Research
- Describing People
- Designing for Human Proportions
- Design Lab Design
- Eating in School
- Getting There
- Growing Plants
- Manufacturing
- Mass Communications
- Nature Trails
- Orientation
- Pedestrian Crossings
- Play Area Design and Use
- Protecting Property
- School Rules
- School Supplies
- School Zoo
- Soft Drink Design
- Traffic Flow
- Using Free Time
- Ways to Learn/Teach
- Weather Predictions

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*See *Goals for the Correlation of Elementary Science and Mathematics*, Houghton Mifflin Co., Boston, 1969.

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USMES Resources

In responding to a long-range challenge, the students and teachers often have need of a wide range of resources. In fact, all of the people and materials in the school and community are important resources for USMES activities. In addition USMES provides resources for both teachers and students. A complete set of all the written materials comprise the USMES library, which should be available in each school using USMES units. These materials include--

1. *The USMES Guide*: This book is a compilation of materials that may be used for long-range planning of a curriculum that incorporates the USMES program. It describes the USMES project, real problem solving, classroom strategies, the Design Lab, the units, and the support materials as well as ways that USMES helps students learn basic skills.

2. *Teacher Resource Books* (one for each challenge): Each of these guides to using USMES units describes a broad problem, explains how students might narrow that problem to fit their particular needs, recommends classroom strategies, presents edited logs from teachers whose classes have worked on the unit, and contains charts that indicate basic skills, processes, and areas of study that students may learn and utilize.

3. *Design Lab Manual*: This guide helps teachers and administrators set up, run, and use a Design Lab--a place with tools and materials in which the students can build things they need for their work on USMES. A Design Lab may be a corner of a classroom, a portable cart, or a separate room. Because many "hands-on" activities may take place in the classroom, every USMES teacher should have a Design Lab Manual.

4. *"How To" Series*: These student materials provide information to students about specific problems that may arise during USMES units. The regular *"How To" Series* covers problems in measuring, graphing, data handling, etc., and is available in two versions--a series of

cartoon-style booklets for primary grades and a series of magazine-style booklets with more reading matter for upper grades. The *Design Lab "How To" Series* is available in two illustrated card versions--one for primary grades and one for upper grades. A complete list of the *"How To" Series* can be found in the *USMES Guide*.

5. Background Papers: These papers, correlated with the *"How To" Series*, provide teachers with information and hints that do not appear in the student materials. A complete list can be found in the *USMES Guide*.

6. Curriculum Correlation Guide: By correlating the twenty-six USMES units with other curriculum materials, this book helps teachers to integrate USMES with other school activities and lessons.

The preceding materials are described in brief in the USMES brochure, which can be used by teachers and administrators to disseminate information about the program to the local community. A variety of other dissemination and implementation materials are also available for individuals and groups involved in local implementation programs. They include *Preparing People for USMES: An Implementation Resource Book*, the USMES slide/tape show, the Design Lab slide/tape show, the Design Lab brochure, videotapes of classroom activities, a general report on evaluation results, a map showing the locations of schools conducting local implementation of USMES, a list of experienced USMES teachers and university consultants, and newspaper and magazine articles.

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Because Tri-Wall was the only readily available brand of three-layered cardboard at the time the project began, USMES has used it at workshops and in schools; consequently, references to Tri-Wall can be found throughout the Teacher Resource Books. The addresses of suppliers of three-layered cardboard can be found in the Design Lab Manual.

Introduction

Using the Teacher Resource Book

When teachers try a new curriculum for the first time, they need to understand the philosophy behind the curriculum. The USMES approach to student-initiated investigations of real problems is outlined in section A of this Teacher Resource Book.

Section B starts with a brief overview of possible student activities arising from the challenge; comments on prerequisite skills are included. Following that is a discussion of the classroom strategy for USMES real problem-solving activities, including introduction of the challenge, student activity, resources, and Design Lab use. Subsequent pages include a description of the use of the unit in primary grades, a flow chart and a composite log that indicate the range of possible student work, and a list of questions that the teacher may find useful for focusing the students' activities on the challenge.

Because students initiate all the activities in response to the challenge and because the work of one class may differ from that undertaken by other classes, teachers familiar with USMES need to read only sections A and B before introducing the challenge to students.

Section C of this book is the documentation section. These edited teachers' logs show the variety of ways in which students in different classes have worked at finding a solution to the challenge.

Section D contains a list of the titles of relevant sets of "How To" Cards and brief descriptions of the Background Papers pertaining to the unit. Also included in section D is a glossary of the terms used in the Teacher Resource Book and an annotated bibliography.

Section E contains charts that indicate the comparative strengths of the unit in terms of real problem solving, mathematics, science, social science, and language arts. It also contains a list of explicit examples of real problem solving and other subject area skills, processes, and areas of study learned and utilized in the unit. These charts and lists are based on documentation of activities that have taken place in USMES classes. Knowing ahead of time which basic skills and processes are likely to be utilized, teachers can postpone teaching that part of their regular program until later in the year. At that time students can study them in the usual way if they have not already learned them as part of their USMES activities.

A. Real Problem Solving and USMES

> *If life were of such a constant nature that there were only a few chores to do and they were done over and over in exactly the same way, the case for knowing how to solve problems would not be so compelling. All one would have to do would be to learn how to do the few jobs at the outset. From then on he could rely on memory and habit. Fortunately--or unfortunately depending upon one's point of view--life is not simple and unchanging. Rather it is changing so rapidly that about all we can predict is that things will be different in the future. In such a world the ability to adjust and to solve one's problems is of paramount importance.**

Real Problem Solving

USMES is based on the beliefs that real problem solving is an important skill to be learned and that many math, science, social science, and language arts skills may be learned more quickly and easily within the context of student investigations of real problems. Real problem solving, as exemplified by USMES, implies a style of education which involves students in investigating and solving real problems. It provides the bridge between the abstractions of the school curriculum and the world of the student. Each USMES unit presents a problem in the form of a challenge that is interesting to children because it is both real and practical. The problem is real in several respects: (1) the problem applies to some aspect of student life in the school or community, (2) a solution is needed and not presently known, at least for the particular case in question, (3) the students must consider the entire situation with all the accompanying variables and complexities, and (4) the problem is such that the work done by the students can lead to some improvement in the situation. This expectation of useful accomplishment provides the motivation for children to carry out the comprehensive investigations needed to find some solution to the challenge.

The level at which the children approach the problems, the investigations that they carry out, and the solutions that they devise may vary according to the age and ability of the children. However, real problem solving involves them, at some level, in all aspects of the problem-solving process: definition of the problem; determination of the important factors in the problem; observation; measurement; collection of data; analysis of the data using graphs, charts, statistics, or whatever means the students can find; discussion; formulation and trial of suggested solutions; clarification of values; decision making; and communications of findings to others. In addition, students become more inquisitive, more cooperative in working with others, more critical in their thinking, more self-reliant, and more interested in helping to improve social conditions.

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*Kenneth B. Henderson and Robert E. Pingry, "Problem-Solving in Mathematics," in *The Learning of Mathematics: Its Theory and Practice,* Twenty-first Yearbook of the National Council of Teachers of Mathematics (Washington, D.C.: The Council, 1953), p. 233.

The USMES Approach

To learn the process of real problem solving, the students must encounter, formulate, and find some solution to complete and realistic problems. The students themselves, not the teacher, must analyze the problem, choose the variables that should be investigated, search out the facts, and judge the correctness of their hypotheses and conclusions. In real problem-solving activities, the teacher acts as a coordinator and collaborator, not an authoritative answer-giver.

The problem is first reworded by students in specific terms that apply to their school or community, and the various aspects of the problem are discussed by the class. The students then suggest approaches to the problem and set priorities for the investigations they plan to carry out. A typical USMES class consists of several groups working on different aspects of the problem. As the groups report periodically to the class on their progress, new directions are identified and new task forces are formed as needed. Thus, work on an USMES challenge provides students with a "discovery-learning" or "action-oriented" experience.

Real problem solving does not rely solely on the discovery-learning concept. In the real world people have access to certain facts and techniques when they recognize the need for them. The same should be true in the classroom. When the students find that certain facts and skills are necessary for continuing their investigation, they learn willingly and quickly in a more directed way to acquire these facts and skills. Consequently, the students should have available different resources that they may use as they recognize the need for them, but they should still be left with a wide scope to explore their own ideas and methods.

Certain information on specific skills is provided by the sets of USMES "How To" Cards. The students are referred only to the set for which they have clearly identified a need and only when they are unable to proceed on their own. Each "How To" Cards title clearly indicates the skill involved--"How to Use a Stopwatch," "How to Make a Bar Graph Picture of Your Data," etc. (A complete list of the "How To" Cards can be found in Chapter IX of the USMES Guide.)

Another resource provided by USMES is the Design Lab or its classroom equivalent. The Design Lab provides a central location for tools and materials where devices may be constructed and tested without appreciably disrupting other classroom activities. Ideally, it is a separate room with space for all necessary supplies and equipment and work space for the children. However, it may be as small as a corner of the classroom and may contain only a few tools and supplies. Since the benefits of real problem solving can be obtained by the students only if they have a means to follow up their ideas, the availability of a Design Lab can be a very important asset.

Optimally, the operation of the school's Design Lab should be such as to make it available to the students whenever they need it. It should be as free as possible from set scheduling or programming. The students use the Design Lab to try out their own ideas and/or to design, construct, test, and improve many devices initiated by their responses to the USMES challenges. While this optimum operation of the Design Lab may not always be possible due to various limitations, "hands-on" activities may take place in the classroom even though a Design Lab may not be available. (A detailed discussion of the Design Lab can be found in Chapter VI of the USMES Guide, while a complete list of "How To" Cards covering such Design Lab skills as sawing, gluing, nailing, soldering, is contained in Chapter IX.)

Work on all USMES challenges is not only sufficiently complex to require the collaboration of the whole class but also diverse enough to enable each student to contribute according to his/her interest and ability. However, it should be noted that if fewer than ten to twelve students from the class are carrying out the investigation of a unit challenge, the extent of their discovery and learning can be expected to be less than if more members of the class are involved. While it is possible for a class to work on two related units at the same time, in many classes the students progress better with just one.

The amount of time spent each week working on an USMES challenge is crucial to a successful resolution of the problem. Each challenge is designed so that the various investigations will take from thirty to forty-five hours, depending on the age of the children, before some solution to the problem is found and some action is taken on the results of the investigations. Unless sessions are held at least two or three times a week, it is difficult for the children to maintain their interest and momentum and to become involved intensively with the challenge. The length of each session depends upon the age level of the children and the nature of the challenge. For example, children in the primary grades may proceed better by working on the challenge more frequently for shorter periods of time, perhaps fifteen to twenty minutes, while older children may proceed better by working less frequently for much longer periods of time.

Student interest and the overall accomplishments of the class in finding and implementing solutions to the challenge indicate when the class's general participation in unit activities should end. (Premature discontinuance of work on a specific challenge is often due more to waning interest on the part of the teacher than to that of the students.) However, some students may continue work on a voluntary basis on one problem, while the others begin to identify possible approaches to another USMES challenge.

Importance of the Challenge

Although individual (or group) discovery and student initiation of investigations is the process in USMES units, this does not imply the constant encouragement of random activity. Random activity has an important place in children's learning, and opportunities for it should be made available at various times. During USMES activities, however, it is believed that children learn to solve real problems only when their efforts are focused on finding some solution to the real and practical problem presented in the USMES challenge. It has been found that students are motivated to overcome many difficulties and frustrations in their efforts to achieve the goal of effecting some change or at least of providing some useful information to others. Because the children's commitment to finding a solution to the challenge is one of the keys to successful USMES work, it is extremely important that the challenge be introduced so that it is accepted by the class as an important problem to which they are willing to devote a considerable amount of time.

The challenge not only motivates the children by stating the problem but also provides them with a criterion for judging their results. This criterion--if it works, it's right (or if it helps us find an answer to our problem, it's a good thing to do)--gives the children's ideas and results a meaning within the context of their goal. Many teachers have found this concept to be a valuable strategy that not only allows the teacher to respond positively to all of the children's ideas but also helps the children themselves to judge the value of their efforts.

Role of the Teacher

With all of the above in mind, it can be said that the teacher's responsibility in the USMES strategy for open classroom activities is as follows:

1. Introduce the challenge in a meaningful way that not only allows the children to relate it to their particular situation but also opens up various avenues of approach.

2. Act as a coordinator and collaborator. Assist, not direct, individuals or groups of students as they investigate different aspects of the problem.

3. Hold USMES sessions at least two or three times a week so that the children have a chance to become involved in the challenge and carry out comprehensive investigations.

4. Provide the tools and supplies necessary for initial hands-on work in the classroom or make arrangements for the children to work in the Design Lab.

5. Be patient in letting the children make their own mistakes and find their own way. Offer assistance or point out sources of help for specific information (such as the "How To" Cards) only when the children become frustrated in their approach to the problem. Conduct skill sessions as necessary.

6. Provide frequent opportunities for group reports and student exchanges of ideas in class discussions. In most cases, students will, by their own critical examination of the procedures they have used, improve or set new directions in their investigations.

7. If necessary, ask appropriate questions to stimulate the students' thinking so that they will make more extensive and comprehensive investigations or analyses of their data.

8. Make sure that a sufficient number of students (usually ten to twelve) are working on the challenge so that activities do not become fragmented or stall.

Student success in USMES unit activities is indicated by the progress they make in finding some solution to the challenge, not by following a particular line of investigation nor by obtaining specified results. The teacher's role in the USMES strategy is to provide a classroom atmosphere in which all students can, in their own way, search out some solution to the challenge.

USMES in the Total School Program

Today many leading educators feel that real problem solving (under different names) is an important skill to be learned. In this mode of learning particular emphasis is placed on developing skills to deal with real problems rather than the skills needed to obtain "correct" answers to contrived problems. Because of this and because of the interdisciplinary nature of both the problems and the resultant investigations, USMES is ideal for use as an important part of the elementary school program. Much of the time normally spent in the class on the traditional approaches to math, science, social science, and language arts skills can be safely assigned to USMES activities. In fact, as much as one-fourth to one-third of the total school program might be allotted to work on USMES challenges. Teachers who have worked with USMES for several years have each succeeding year successfully assigned to USMES activities the learning of a greater number of traditional skills. In addition, reports have indicated that students retain for a long time the skills and concepts learned and practiced during USMES activities. Therefore, the time normally spent in reinforcing required skills can be greatly reduced if these skills are learned and practiced in the context of real problem solving.

Because real problem-solving activities cannot possibly cover all the skills and concepts in the major subject areas, other curricula as well as other learning modes (such as "lecture method," "individual study topics," or programmed instruction) need to be used in conjunction with USMES in an optimal education program. However, the other instruction will be enhanced by the skills, motivation, and understanding provided by real problem solving, and, in some cases, work on an USMES challenge provides the context within which the skills and concepts of the major subject areas find application.

In order for real problem solving taught by USMES to have an optimal value in the school program, class time should be apportioned with reason and forethought, and the sequence of challenges investigated by students during their years in elementary school should involve them in a variety of skills and processes. Because all activities are initiated by students in response to the challenge, it is impossible to state unequivocally which activities will take place. However, it is possible to use the documentation of activities that have taken place in USMES trial classes to schedule instruction on the specific skills and processes required by the school system. Teachers can postpone the traditional way of teaching the skills that might come up in work on an USMES challenge until later in the year. At that time students can learn the required skills in the usual way if they have not already learned them during their USMES activities.

These basic skills, processes, and areas of study are listed in charts and lists contained in each Teacher Resource Book. A teacher can use these charts to decide on an overall allocation of class time between USMES and traditional learning in the major subject disciplines. Examples of individual skills and processes are also given so that the teacher can see beforehand which skills a student may encounter during the course of his investigations. These charts and lists may be found in section E.

Ways In Which USMES Differs From Other Curricula

As the foregoing indicates, USMES differs significantly from other curricula. Real problem solving develops the problem-solving ability of students and does it in a way (learning-by-doing) that leads to a full understanding of the process. Because of the following differences, some teacher preparation is necessary. Some teachers may have been introduced by other projects to several of the following new developments in education, but few teachers have integrated all of them into the new style of teaching and learning that real problem solving involves.

1. New Area of Learning--Real problem solving is a new area of learning, not just a new approach or a new content within an already-defined subject area. Although many subject-matter curricula

include something called problem solving, much of this problem solving involves contrived problems or fragments of a whole situation and does not require the cognitive skills needed for the investigation of real and practical problems. Learning the cognitive strategy required for real problem solving is different from other kinds of learning.

3. Interdisciplinary Education--Real problem solving integrates the disciplines in a natural way; there is no need to impose a multi-disciplinary structure. Solving real and practical problems requires the application of skills, concepts, and processes from many disciplines. The number and range of disciplines are unrestricted and the importance of each is demonstrated in working toward the solution of practical problems.

3. Student Planning--To learn the process of problem solving, the students themselves, not the teacher, must analyze the problem, choose the variables that should be investigated, search out the facts, and judge the correctness of the hypotheses and conclusions. In real problem-solving activities the teacher acts as a coordinator and collaborator, not as an authoritative source of answers.

4. Learning-by-Doing--Learning-by-doing, or discovery learning as it is sometimes called, comes about naturally in real problem solving since the problems tackled by each class have unique aspects; for example, different lunchrooms or pedestrian crossings have different problems associated with them and, consequently, unique solutions. The challenge, as defined in each situation, provides the focus for the children's hands-on learning experiences, such as collecting real data; constructing measuring instruments, scale models, test equipment, etc.; trying their suggested improvements; and (in some units) preparing reports and presentations of their findings for the proper authorities.

5. Learning Skills and Concepts as Needed--Skills and concepts are learned in real problem solving

as the need for them arises in the context of the work being done, rather than having a situation imposed by the teacher or the textbook being used. Teachers may direct this learning when the need for it arises, or students may search out information themselves from resources provided.

6. Group Work--Progress toward a solution to a real problem usually requires the efforts of groups of students, not just individual students working alone. Although some work may be done individually, the total group effort provides good opportunities for division of labor and exchange of ideas among the groups and individuals. The grouping is flexible and changes in order to meet the needs of the different stages of investigation.

7. Student Choice--Real problem solving offers classes the opportunity to work on problems that are real to them, not just to the adults who prepare the curriculum. In addition, students may choose to investigate particular aspects of the problem according to their interest. The variety of activities ensuing from the challenge allows each student to make some contribution towards the solution of the problem according to his or her ability and to learn specific skills at a time when he or she is ready for that particular intellectual structure.

B. General Papers on Getting There

1. OVERVIEW OF ACTIVITIES

Challenge:

Find ways to overcome the difficulties in getting from one place to another.

Possible Class Challenges:

What can we do to help students find their way around the school?

What is the best way for us to get to the neighborhood library and playground from school?

Children in a variety of grade levels may respond enthusiastically to this challenge as they discuss the problems they face in getting around their school or community. In some classes the focus of the children's investigations is getting around the school or simply going from their homes to school and back, while other classes may investigate ways to get to and return from recreational, educational, and cultural facilities within the community. Once students have realized that a problem of getting from one place to another exists, either for themselves or for others in the school and/or community, the children may decide to work in small groups on different aspects of the problem. The flow chart suggests some activities that students may undertake.

The class may wish to survey other students for their opinions on the problem and its possible solutions. The tallying and graphing of their survey data will help them decide which tasks should be undertaken first and what data they need to collect. For those classes concerned with getting around the school, the groups may include children working on mapping the school, color-coding various routes around the school, renumbering rooms, posting room signs, or making plans to reroute traffic through the building. Classes whose interest is getting around the community may form groups to work on making community maps, writing clear and concise directions, investigating public transportation--routes, costs, and schedules, and/or checking on the availability of bicycle paths.

Examination of survey data and discussions within their groups will help the children to determine what data they need to collect. In order to prepare new maps or to update already existing ones, measurements of the building may have to be made. Children interested in routing traffic within the school may collect data on the distances each route involves. However, thinking that the best route may be the quickest, the children might decide that time is an important factor in comparing several routes. They may want to gather data from time trials in an effort to decide on the best of several routes.

The various solutions are tested and their effectiveness determined through time trials, surveys, etc.; improvements are then made. In some classes students may take direct action on their findings, while in other classes final action on the challenge can take the form of presentations to individuals and groups that have the power to effect the proposed solutions.

Follow-up activities may arise naturally as investigations of the Getting There challenge end. Students may want to use the information they have collected to orient students and/or others to the school and community. A handbook for all students may be deemed important--a perfect introduction to the Manufacturing unit. Students working on getting around the community may become involved in the Bicycle Transportation unit.

Although many of these activities may require skills and concepts new to the children, there is no need for preliminary work on these skills and concepts because the children can learn them when the need arises. In fact, children learn more quickly and easily when they see a need to learn. Consider counting: whereas children usually count by rote, they can, through USMES, gain a better understanding of counting by learning or practicing it within real contexts. In working on Getting There, children also learn and practice graphing, measuring, working with decimals, and dividing. Although dividing seems necessary to compare fractions or ratios, primary children can make comparisons graphically or by subtracting medians (half-way values). Furthermore, instead of using division to make scale drawings, younger children can convert their measurements to spaces on graph paper. Division may be introduced during calculation of percentages or averages.

2. CLASSROOM STRATEGY FOR GETTING THERE

The Getting There unit is centered on a challenge--a statement that says, "Solve this problem." Its success or failure in a classroom depends largely on (1) the relevance of the problem for the students and (2) the process by which they define and accept the challenge. If the children see the problem as a real one, they will be committed to finding a solution; they will have a focus and purpose for their activities. If the students do not think the problem affects them, their attempts at finding solutions will likely be disjointed and cursory.

The Getting There challenge--"Finding ways to overcome the difficulties from one place to another"--is general enough to apply to many situations. Students in different classes define and reword the challenge to fit the particular problems of their school and thus arrive at specific class challenges. "How can we help new students find their way around the school?" might be the challenge for a class with several new students.

The Process of Introducing the Challenge

Given that a problem exists, how can a teacher, without being directive, help the students identify the challenge that they will work on as a group? There is no set method because of variations among teachers, classes, and schools and among the USMES units themselves. However, USMES teachers have found that certain general techniques in introducing the challenge are helpful.

One such technique is to turn a discussion of some recent event toward a Getting There challenge, such as when a new student is introduced.

> *When a new student was introduced to a kindergarten class, the children were presented with the problem of how to help him find his way around the school without getting lost. They excitedly offered several suggestions--take him there, have him ask a teacher, make a map. They later broke into groups to make a map of their floor.*

Frequently, the children will volunteer complaints about not being able to get to places, providing an opportunity for the teacher to introduce a Getting There challenge.

A Getting There challenge may arise from the children's work on another USMES unit. For example, children working on Bicycle Transportation might decide to find the best bike route from one place to another. Students working on Orientation may realize that many people might have difficulty getting around the school and begin to work on that problem.

When children working on another USMES challenge encouter a problem that leads to a Getting There challenge, one group of children may begin work on this second challenge while another continues on the first. However, there should be at least ten or twelve students working on any one challenge; otherwise the children's work may be fragmented or superficial or may break down completely.

The Getting There challenge may also evolve during a discussion of a specific topic or a current social issue such as the energy problem or the economy and how it affects them.

To insure that they would have field trips in spite of gasoline shortages and the elimination of school buses for outings, one sixth-grade class investigated the use of public transportation for their trips. Using system maps, they compiled directions for getting to various places of interest in their city.

While discussing their social studies unit--"All Around Me"--and talking about children in the school, students in one first-grade class became interested in the Getting There challenge. Posters depicting children walking to school were examined by the children and led them to wonder about the rooms in their school and whether they could find their way to various rooms in the school.

Sometimes the discussion of a broad problem may encompass the challenges of several related units. For example, a discussion of problems encountered in getting to school may lead to Bicycle Transportation, Pedestrian Crossings, Orientation, Traffic Flow, or Getting There, depending on which problems the children identify.

An experienced USMES teacher is usually willing to have the children work on any one of the several challenges that may arise during the discussion of a broad problem. While this approach gives the children the opportunity to select the challenge they are most interested in investigating, it does place on the teacher the additional responsibility of being prepared to act as a resource person for whichever challenge is chosen.

Classroom experience has shown that children's progress on a Getting There challenge may be poor if the teacher and students do not reach a common understanding of what the challenge is before working on it. Having no shared focus for their work, the children will lack the motivation inherent in working together to solve a real problem. As a result, they may quickly lose interest.

A similar situation occurs if the teacher, rather than ensuring that the children have agreed upon a challenge, merely assigns a series of activities. Although the teacher may see how these activities relate to an overall goal, the children may not.

Initial Work on the Challenge

Once a class has decided to work on a Getting There challenge, USMES sessions should be held several times a week, but they need not be rigidly scheduled. When sessions are held after long intervals, students often have difficulty remembering exactly where they were in their investigations and their momentum diminishes.

During the initial session, children list difficulties in getting places, and the list usually is long. By lumping together similar complaints and by choosing only a few major problems to work on at first, the class can arrive at a manageable challenge. If the students try to tackle too many problems at once, their investigations will be superficial.

> *One sixth-grade class began work on helping students find their way around the school by listing the things that they might do, such as possible routes for sidewalks, identifying signs for portable classrooms, signs, and a school directory. When they tried to tackle all these problems, the students encountered difficulties. They realized too late that they had tried to work on too many solutions at once. The two sign groups finished, the sidewalk group reorganized and finished on their own, but the directory group disbanded and joined other groups.*

Once they have agreed upon a problem, the children suggest possible approaches to solving it. Next, they categorize these suggestions, list the tasks necessary to carry out their ideas, and set priorities for these tasks. Most of these tasks are carried out by small groups of children.

> *Fifth-grade students in one class working on the Getting There challenge of determining ways to help students find their way around the school met frequently to review the challenge and their work on the unit. After the class completed investigations to prove that the problem did exist and met to brainstorm possible solutions, they formed several small groups to work on areas designated by the class, for example, wall signs, "traffic man," room numbers, and map rack. As the unit progressed and as discussion shows that additional data or tasks were necessary, the students regrouped to complete the necessary work.*

As various groups complete their work, their members join other groups or form new groups to work on additional tasks. However, if too many groups are formed, work on the challenge can become fragmented. The teacher finds it impossible to be aware of the progress and problems of each group; in addition, the small number of students in each group lessens the chance of varied input and interaction.

Refocusing on the Challenge

As children work on a Getting There challenge, the children's attention should, from time to time, be refocused on that challenge so that they do not lose sight of their overall goal. Teachers find it helpful to hold periodic class discussions that include group reports on their investigations. Such sessions help the students review what they still need to do in order to recommend improvements. These discussions also provide an opportunity for students to evaluate their own work and exchange ideas with their classmates. Without these sessions there is a strong possibility that the children's efforts will overlap unnecessarily. (Another consequence of having too many groups is that not every group can be given enough time to report to the class.)

One fifth-grade class worked on several solutions to the problem of getting around their school, including signs, room numbers, and maps. Because they had frequent class discussions, each group knew what the others were doing and offered suggestions for improvements. As a result, all the groups completed their tasks successfully.

Resources for Work on the Challenge

When children try to decide on solutions before collecting and analyzing enough data or when they encounter difficulties during their investigations, the USMES teacher may find the technique of asking open-ended questions that stimulate the students to think more comprehensively and creatively about their work. For example, instead of telling the students that they need to conduct a survey or collect data on times to get places, the teacher might ask them how they can prove that a problem exists. Examples of other nondirective, thought-provoking questions are given later in this section.

The teacher may also refer to the "How To" Cards relating to Getting There for information about specific skills, such as using a stopwatch or drawing graphs. If many students or even the entire class need help in particular areas, such as conducting an opinion survey or finding averages, teachers should conduct skill sessions as these needs arise. (Background Papers on topics relating to Getting There activities may be helpful.)

USMES teachers can also assist students by making it possible for them to carry out tasks involving hands-on activities. If the children's tasks require them to design and construct items, such as signs, scale layouts, or map racks, the teacher should make sure that they have access to a Design Lab--any collection of tools and materials kept in a central location (in part of the classroom, on a portable cart, or in a separate room). A more detailed description of the Design Lab may be found in the USMES Guide.

Valuable as it is, a Design Lab is not necessary to begin work on Getting There. The Design Lab is used only when needed, and, depending on the investigations chosen by the children, the need may not arise at all.

One sixth-grade class responded successfully to the Getting There challenge without using the Design Lab; they started by discussing getting around the community. After investigating the problem and surveying other students to determine their preferences, they convassed their community with petitions that indicated support for one of their proposals, a bicycle path, collected data on costs and routes and presented their findings to the County Commissioners.

To carry out construction activities in schools without Design Labs, students may scrounge or borrow tools and supplies from parents, local businesses, or other members of the community. The extent to which any Design Lab is used varies with different classes because the children themselves determine the direction of the Getting There investigations.

Culminating Activities

Student investigations on Getting There generally continue until the students have implemented one or more solutions and tested and evaluated their effectiveness. The students may also make subsequent improvements to their solutions. For example, classes focusing on the problems of getting around the school may choose to prepare and post maps of the building, posters or directional signs, and/or room signs and room numbers. The effectiveness of these can be determined by comparing the times students took to find given areas or rooms both before and after the improvements were made. In other classes, students investigating ways of getting around the community may petition the city council for bicycle paths and/or prepare maps for other students.

> *One fifth-grade class devised several solutions to the problem of getting around their school, including directional signs, room numbers, maps, and a device called a "traffic man." They evaluated their efforts by comparing the times found before the improvements were installed with the times found after the improvements were in place; they concluded that their solutions had indeed helped students find their way around.*

> *One sixth-grade class presented their County Commissioners with data on costs and routes for a bicycle path along with petitions that indicated support for this proposal. The commissioners were impressed with the students' proposal and decided to conduct a feasibility study on the proposed route.*

3. USE OF GETTING THERE IN THE PRIMARY GRADES

Children in the primary grades often have considerable difficulty in getting from one place to another within the school and within the community. They may have trouble finding certain rooms outside their particular area of the school, or they may have difficulty in getting there because of construction or repairs. One first-grade class had difficulty in getting to the buses that were to take them home--they couldn't see the numbers on the buses, and they were often pushed about by other students.

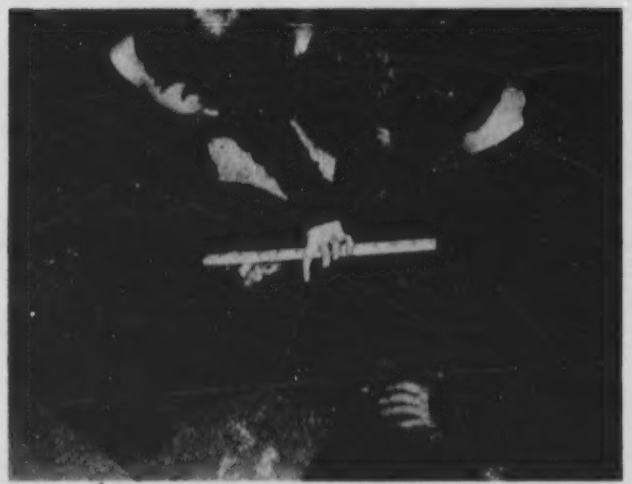
When difficulties in getting around are discussed, the children choose the problem that seems most important to them and try to find solutions. They often quickly suggest various solutions during a discussion. The first-grade class above immediately suggested several alternate routes to the buses and also offered suggestions on dealing with pushing. Other classes have suggested ways to help new students find their way around the primary-grade area of the school.

In order to get a complete list of the concerns of other students, some classes decide to develop and administer a survey to other classes before deciding what to do. Other classes may decide to confine the survey to their own class. A trial within the classroom will quickly show that survey questions should be clear and concise in order to obtain the desired information. The trial will also show that the number of questions should be kept to a minimum because of the time consumed in tallying the results. The children might also decide to survey a sample of students rather than the whole student body.

Once the data have been collected, the children will have to put them in a form that can be interpreted; data representation can take the form of simple graphs or charts.

In some classes several groups are formed to develop various solutions to the Getting There challenge. However, teachers in other primary classes work with the whole class on one aspect of the problem at a time. Some children may be interested in preparing directional signs to post in the halls. They might map out several routes to each different location and hold timed trials to determine which route is the quickest. When representations of their data have been completed, they decide to find the median time for each route in order to enable them to compare routes and choose the ones for which directional signs will be made--medians can be determined easily by children in the primary grades. Ideas for the design and construction of the signs may be presented to their classmates during a full class discussion at which time a decision is made.

Many primary classes have deemed it extremely important to prepare a rough map of the school building. The children might decide to check an existing map by making measurements using a trundle wheel, folding ruler, tape measure, pacing, or their bodies. They might then use graph paper to convert their measurements to "blocks" using the same scale as that of the map. This process involves measuring and scaling and offers the chance for the acquisition of new skills or the practice of old ones. Class and group discussions may help them to realize that only parts of the building, such as walls and doors, need to be measured because the furniture can be arranged differently the following year. These tasks are made easier by the fact that the children have a reason to do them. The class might also decide to post room signs on all the doors or conduct tours, which would have to be planned and scheduled. (In some schools older children help primary children with the construction of graphs and maps.)



As these activities continue, frequent class discussions are held in which groups report to the class, decisions are made, and students help each other with problems that develop. Questions (as needed) from the teacher serve as a continuing focus on the problem and a way of judging which if any, new skills are needed. Such discussions offer young children practice in language arts skills.

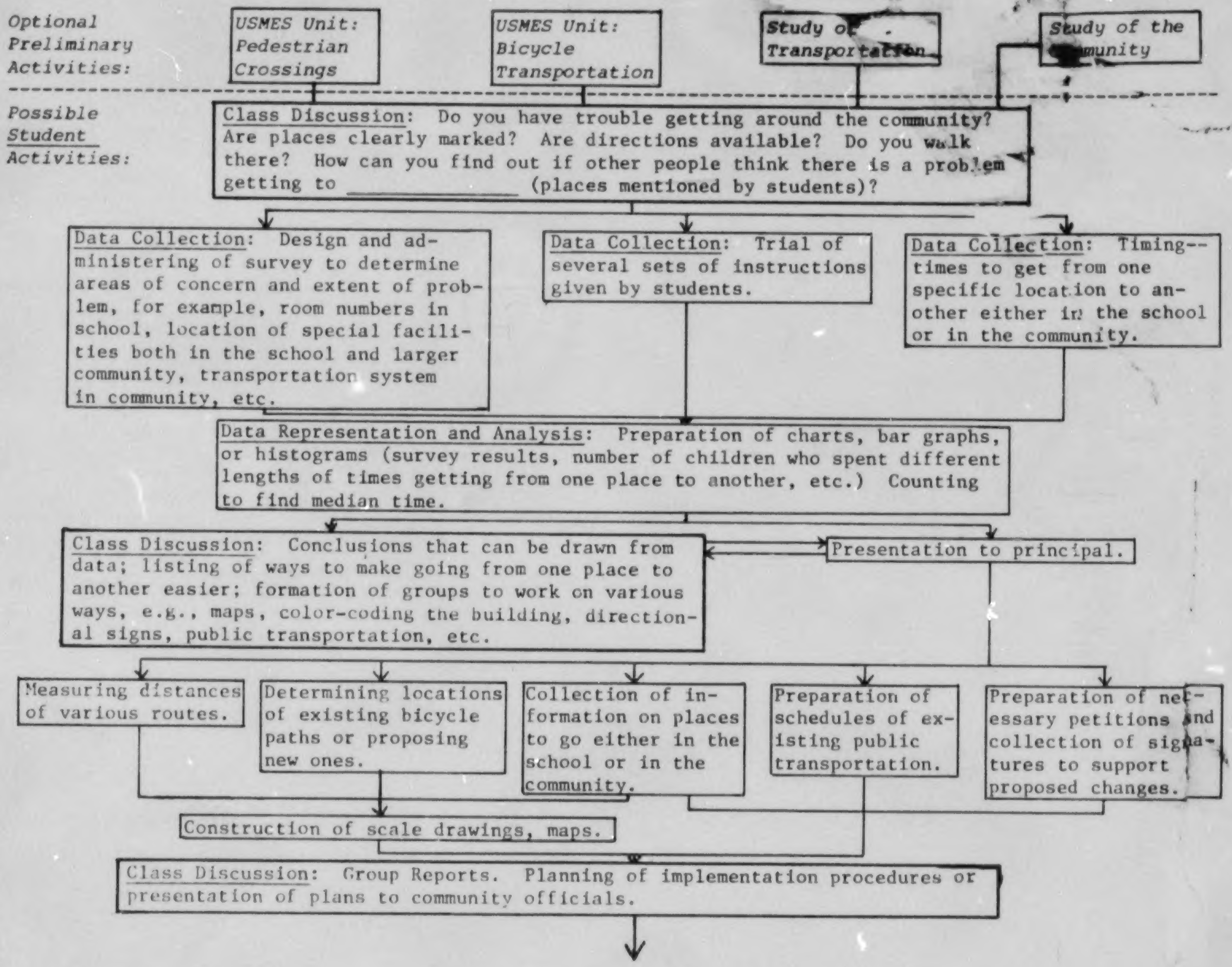
The children might decide to evaluate the effectiveness of their efforts after their changes have been implemented. This may be accomplished through timed trials, discussions, or surveys. After working on Getting There, the children may face other problems with an increased ability to deal with them successfully.

4. FLOW CHART

The following flow chart presents some of the student activities--discussions, observations, calculations, constructions--that may occur during work on the Getting There challenge. Because each class will choose its own approach to the challenge, the sequence of events given here represents only a few of the many possible variations. Furthermore, no one class is expected to undertake all the activities listed.

The flow chart is not a lesson plan and should not be used as one. Instead, it illustrates how comprehensive investigations evolve from the students' discussion of a Getting There problem.

Challenge: Find ways to overcome difficulties in getting from one place to another.



Optional Preliminary Activities:

USMES Unit: Pedestrian Crossings

USMES Unit: Bicycle Transportation

Study of Transportation

Study of the Community

Possible Student Activities:

Class Discussion: Do you have trouble getting around the community? Are places clearly marked? Are directions available? Do you walk there? How can you find out if other people think there is a problem getting to ______________ (places mentioned by students)?

Data Collection: Design and administering of survey to determine areas of concern and extent of problem, for example, room numbers in school, location of special facilities both in the school and larger community, transportation system in community, etc.

Data Collection: Trial of several sets of instructions given by students.

Data Collection: Timing--times to get from one specific location to another either in the school or in the community.

Data Representation and Analysis: Preparation of charts, bar graphs, or histograms (survey results, number of children who spent different lengths of times getting from one place to another, etc.) Counting to find median time.

Class Discussion: Conclusions that can be drawn from data; listing of ways to make going from one place to another easier; formation of groups to work on various ways, e.g., maps, color-coding the building, directional signs, public transportation, etc.

Presentation to principal.

Measuring distances of various routes.

Determining locations of existing bicycle paths or proposing new ones.

Collection of information on places to go either in the school or in the community.

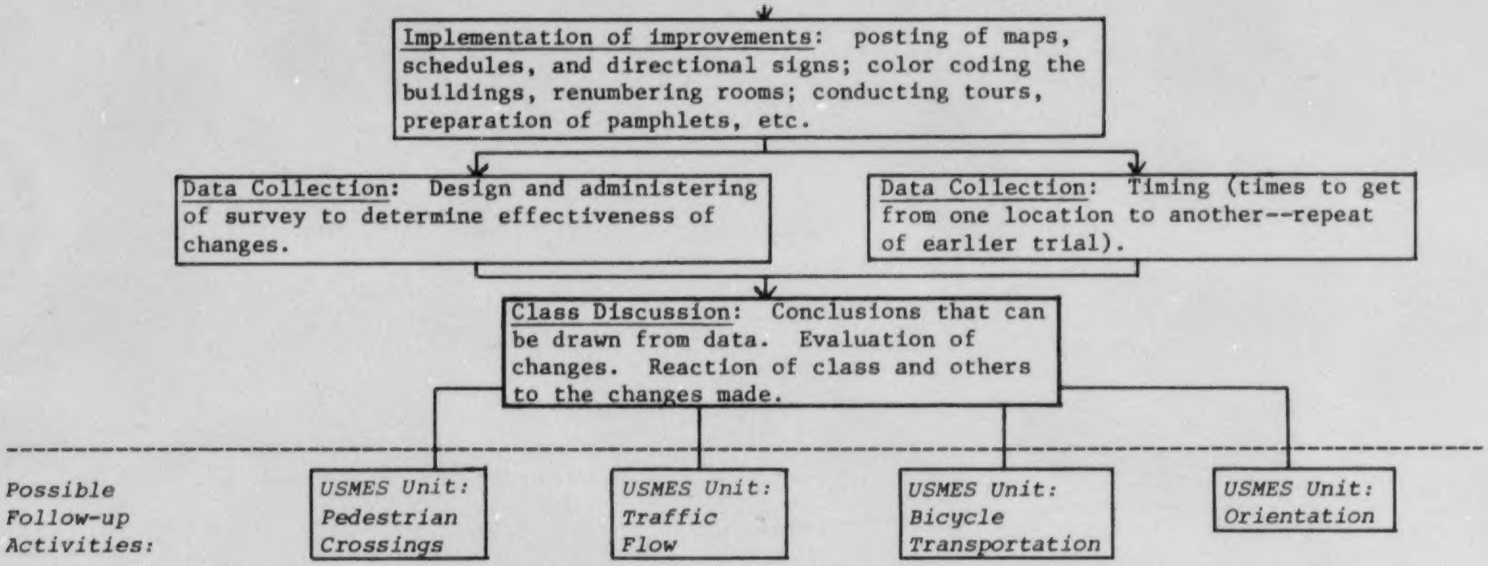
Preparation of schedules of existing public transportation.

Preparation of necessary petitions and collection of signatures to support proposed changes.

Construction of scale drawings, maps.

Class Discussion: Group Reports. Planning of implementation procedures or presentation of plans to community officials.

(Continued on next page.)



Implementation of improvements: posting of maps, schedules, and directional signs; color coding the buildings, renumbering rooms; conducting tours, preparation of pamphlets, etc.

Data Collection: Design and administering of survey to determine effectiveness of changes.

Data Collection: Timing (times to get from one location to another--repeat of earlier trial).

Class Discussion: Conclusions that can be drawn from data. Evaluation of changes. Reaction of class and others to the changes made.

Possible Follow-up Activities:

USMES Unit: Pedestrian Crossings

USMES Unit: Traffic Flow

USMES Unit: Bicycle Transportation

USMES Unit: Orientation

5. A COMPOSITE LOG*

This hypothetical account of a primary-level class describes many of the activities and discussions mentioned in the flow chart. The composite log shows only one of the many progressions of events that might develop as a class investigates the Getting There challenge. Documented events from actual classes are italicized and set apart from the text.

During the first week of the school year, a group of children in a combination second/third-grade class ask the teacher if they may go to the school library. The teacher asks them if they remember how to get there and when the students respond that they do, they are given permission to go. Ten minutes later the group returns and reports that they were unable to find their way. The teacher calls the class together for a discussion of what took place.

> *Children in a kindergarten class in Arlington, Massachusetts, had difficulty getting to the school library. After several children were unable to find their way using directions from others, the class met to discuss why they had been unable to get there. (See log by Michael McCabe.)*

The children who were unable to get to the library tell their classmates and teacher that each of them knows how to get to the library from their last year's classroom but do not know the route. Some classmates agree that this has also been a problem for them, adding that it isn't finding just the library that presents difficulty but finding other rooms as well. One child explains that this year they are expected to move around the building more often without adult supervision and that they must find the rooms starting from a different location.

The children are very willing to share their experiences when asked by the teacher to tell what they usually do when they cannot find the way to a certain place. In general, the children's responses show that they (1) try again, (2) ask for directions, (3) have someone show the way, and (4) give up. Before the discussion ends, several students say that they do not have difficulty getting from one place to another in the school. The teacher asks the children how they can find the extent of the problem. The class decides to have trial trips to other rooms to determine how widespread the problem is.

> *During a discussion by a class of fifth graders in Howell, Michigan, of the difficulties they had encountered finding their way around the school,*

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*Written by USMES staff

> *several students insisted that they knew their way around the building. These students were asked to find a certain room in the school as quickly as they could, have the teacher sign the note indicating that they had found the room, and return to the classroom. (See log by Janet Sitter.)*

The class meets on the following day to discuss plans for the trials. They prepare a list of places to which they must go from their homeroom. Three locations on the list are selected as destination points--the music room, the nurse's office, and the art room. The class decides to have nine children participate in the trials with three going to each location individually.

The students' names are written on slips of paper and put in a box; nine names are selected, and each of the nine chooses a piece of paper from another box on which is written one of the three locations. This information is recorded on the board by one of the students.

The children agree that at some point during the afternoon each of the nine children will set out to find their way to the room indicated on their slip of paper. After a considerable amount of discussion, the class decides that upon arriving at their destination, the nine children will sign their slips of paper, leave them with the teacher in the room, return to the classroom, and draw their routes on paper which would be waiting for them. The children add the stipulation that the nine children are not to talk about their task with anyone until all of the trials are completed.

> *Children in the Howell class met to discuss the results of their classmates' attempt to find a classroom in the school. It had taken them a surprisingly long time to return to their classroom--a direct result of the "round about" route they took. Other students were asked to count the number of bathrooms in the school and were amazed that they were only able to locate half of them. (See log by Janet Sitter.)*

The children are extremely excited as they gather for a discussion of the trials during the next class session. All nine children were able to reach their goal—each with varying amounts of difficulty. Many of the nine children voice surprise at the difficulties they encounter; for example, two children tell of having trouble locating stairs that went to the section of the building in which the nurse's office and music room were located, while others report that the rooms are not marked by name and they do not know the room numbers. Only two students report that they had no difficulty at all and, of the two, one student had made the trip earlier in the week and was familiar with the route. The class then generally agrees that the problem of getting to places is a real one, and that they should look for ways to make it easier to get from one place to another.

At this point a classmate asks one child who had no trouble how she had gone. Using her drawing, the child traces the path she followed from the homeroom to the nurse's office. Her classmates seem satisfied with her explanation until another child who had also gone to the nurse's office says that he took a different route, and the third child announces that she used a route which is not only different from those used by the other two, but better! Needless to say, there is a heated debate over her last assertion.

As the class examines the other drawings, it becomes apparent that different routes were tried, and each child thinks his/her route to a certain location is the best. The class decides to have a second set of trials to determine the best route to each location. Two routes to each location are chosen by the children for the second trials. Twelve more names are picked from the box, and these twelve children select a particular route to follow by drawing lots from another box.

Before ending the session, the children discuss how they can determine which routes are best. After considerable discussion, they decide to time the trials; they are convinced that the route that takes the shortest time to travel will be the best. Twelve children are selected to be timers; they are directed by their classmates to accompany one of the children who participates in the trial, time the journey and record the data. Although these children say that they have used a stopwatch before, they want to read the "How To" booklet--*"How To" Use a Stopwatch"* before the trials begin to refresh their memory. The event is scheduled for the next morning with a class discussion immediately following the last trial.

The next afternoon the class meets to discuss the second round of trials. The student timers begin recording on the front chalkboard the data listed on the next page for the class to examine and discuss.

Name	Destination	Route	Time
John	Nurse	1	3 min. 30 sec.
Mary	Nurse	2	6 min.
Jessie	Nurse	1	5 min. 40 sec.
Bob	Nurse	2	5 min. 35 sec.
Noah	Music	1	2 min. 45 sec.
Anne	Music	1	4 min.
Marsha	Music	2	3 min. 56 sec.
Joey	Music	2	2 min. 50 sec.
Susan	Art	1	3 min. 42 sec.
Ellen	Art	2	2 min.
Neil	Art	1	3 min. 30 sec.
Mitchell	Art	2	3 min. 38 sec.

One child immediately comments that one of the times to the nurse's room is much shorter than the others. Other students look at the data more carefully and notice that several other times are much shorter than the others in the group. There is a great deal of discussion as the class tries to determine the reason for this. Finally, one student asks if all those timed had walked from homerooms to their destination. The four children whose times were shorter admit that they ran rather than walked. Some of the children are upset, but the child who asked the question points out that no one has broken a rule because the class had not indicated whether they should run or walk.

After some more discussion, the concensus of the class is that the data is invalid and that those trials must be repeated. The children then decide that more children should be involved in the timings because two people per route does not provide an accurate measure. They break up into three groups with eleven children per group. Each group works on one location with eleven people trying each route. The class agrees to follow the procedures established for the earlier trial with the additional stipulation that everyone must walk the route. The next set of trials are scheduled to take place during the next two days. The class decides to bring their data to a class discussion which they schedule for the third day.

Fourth graders scheduled to join the student body of the Howell School were asked to participate in timed trials of getting from one place to another.

> *The fifth-grade students selected six places for the visitors to locate. Timers were selected and a form on which the data could be recorded was prepared. The next day the students compiled charts to represent their data. They planned to repeat the trials and use the data to determine the effectiveness of their solution to the problem. (See log by Janet Sitter.)*

The groups meet on the next day to schedule their trials so as to minimize disruptions to other classes. Each group selects additional children to assist with the timings. The trials go smoothly with only two exceptions: in both cases the timers forget to start the stopwatch and the test is repeated. As each group completes its trials, the members meet to compile their data. Each group lists the names of the children and the times to travel each route. (The time data compiled by the group going to the art room can be seen below.)

Time to Reach Art Room Using Different Routes

Route A	Route B
3 min. 7 sec.	3 min. 4 sec.
3 min. 18 sec.	3 min. 25 sec.
3 min. 22 sec.	3 min. 27 sec.
3 min. 25 sec.	3 min. 27 sec.
3 min. 26 sec.	3 min. 29 sec.
3 min. 26 sec.	3 min, 33 sec.
3 min. 28 sec.	3 min. 33 sec.
3 min. 30 sec.	3 min. 33 sec.
3 min. 45 sec.	3 min. 53 sec.
4 min. 10 sec.	4 min. 0 sec.
4 min. 10 sec.	4 min. 2 sec.

Several children in the group complain that they are confused by what the numbers mean. The teacher joins the group and suggests that they find a way to show what the data mean. The teacher suggests that other children might be having the same problem and calls the class together for a brief class discussion. The art group summarizes their own experiences for the other children. Many classmates are experiencing the same inability to visualize what the "numbers" mean. The teacher says that they can use strips of paper which will show the length of time for each trial.

Before the next class session the teacher looks over the class data and determines the range of data from all the groups. She places a strip of masking tape on the top of a low table in the math area. On the tape she marks off a scale for the different lengths of times represented by the class data.* She also makes sure that there are adding machine paper, pencils, and scissors in the room. During a class discussion she suggests that each group spend some time in the math area preparing bars for their graph.

After the teacher uses one piece of data to show how to determine the proper length to cut the adding machine paper, each child finds his/her time--for example, 4 minutes 12 seconds--marked on the strip of masking tape and measures a piece of adding machine paper that is as long as the distance between the zero mark on the tape and the time. The adding machine paper is marked at the right length, cut, and labeled with the data it represents. The children plan to tape their group's bars for each route on large pieces of paper so that they can compare the lengths of time it took to travel the different routes. Several children remind their classmates to label each bar with the name of the person and to label each set of bars with the group name and the route taken. The groups take turns working in the math area and preparing their graphs; the teacher spends some time with each group, asking and answering questions and assisting when needed.

Later in the day the class meets to examine their graphs. Each group has two graphs—one for each route. The children soon realize that they need one number to represent the times for each route so that they can make a decision as to which route is the fastest for getting to each of the three locations. The teacher asks the children if they have ever heard of the word "median"; several say, "Yes," but are not sure of what it means. She explains it to them in terms of the data they have collected and distributes several sets of the "How To" Cards, "How to Describe Your Set of Data by Using the Middle Piece (Median)." The children read the cards and then cut their graphs so that they can put the bars in order of size from smallest to largest. They quickly find the middle bar from each set of data and make a list of the information on the board. In the case of the art group whose data appeared earlier, the medians were found to be 3 minutes 26 seconds for Route A and 3 minutes

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*Older children might skip this step and make a regular bar graph showing the median time for reaching each of the four locations.--ED.

33 seconds for Route B. The children decide that Route A is the best route because it is the quickest. Because some groups still have trouble comparing numbers, the results of each group's trials are used to make a bar graph which has one bar for each route to each of the three locations.

During the next class session the children meet to discuss their challenge of "Find ways to make it easier to get from one place to another in the school." Several children say that knowing a quick route to the nurse's office, the art room, or the music room has helped them a great deal. A classmate who was in the group working on routes to the nurse's office comments that she still has difficulty remembering the best route from homeroom to the art room. The teacher asks if there is some way of making it easier to get to a place no matter in which group one worked. There is a lot of talking, and soon children begin to make suggestions. The children's suggestions which are listed on the board include--

1. conduct tours
2. color-code the building with lines
3. post directional signs
4. post room signs
5. renumber rooms
6. prepare maps

A kindergarten class in Brooklyn, N.Y., offered several suggestions for telling people how to get to the office from their room--look for it, ask someone, draw a map. After discussing what a map was, they broke into groups to draw maps showing the way to the office. (From log by Lorraine Shapiro.)

The class discusses the pros and cons of each suggestion. The children agree to select three items on which to work initially and plan to do more if time permits. The suggestions which receive the biggest number of votes are (1) preparation of maps, (2) posting room signs, and (3) color-coding the building. One child suggests that the principal be invited to the room to hear their ideas before work begins and remarks that it would be horrible to do a lot of planning and then discover that their ideas could not be carried out. The class is eager to begin but agrees to the meeting.

A group meets during language arts time to write a letter to the principal asking that a time be scheduled during the following week for the principal to come to their homeroom. Four children are selected by the class to make a presentation to the principal. These four students decide to meet before the arranged time to plan the meeting and then to try it out before the class. After the class trial, the group makes changes in the presentation according to the students' suggestions.

> *Students in a sixth-grade class in Arlington, Massachusetts, worked on the challenge of finding ways to use public transportation for field trips. They chose possible sites for field trips and investigated routes, costs, and schedules of public transportation. Several classes in the school found this information, which was put in a booklet, very useful. (See log by Madeline Davidson.)*

> *After their winter vacation, students in the Howell class met to propose solutions to the grade-wide problem of getting around the school building. In an effort to help themselves and others find their way around the school, they proposed many solutions and formed groups to work on wall and door signs, room numbers, a color-coded chart, a map rack, and a "traffic man". (See log by Janet Sitter.)*

The principal arrives on the day of the presentation and the four students begin by bringing her up to date on their investigations. They identify the problem for her and related why and how they became interested in it. Using the graphs they have prepared, they explain their data and the results of their experiment. They conclude that since their limited efforts have made a difference to their class, a more wide-scale effort would increase the benefits to many students.

The principal raises some questions about their information which the class joins in answering. Finally, the principal asks them what they would like to do. One student explains the three proposals. The principal agrees with the children's assessment of the situation, stating that many people have had difficulty finding their way around the building when they first come to the school--students, teachers, and parents. While she encourages them to pursue two of the three suggestions, she objects to color-coding the building by painting lines on the walls. Her objection is based on earlier experiences in the school when room assignments changed often. She feels that painting lines is a very permanent action and asks whether they could suggest something else.

The children offer to post directional signs in the building to help children get from one place to another. This is accepted by the principal and the presentation ends. The children are extremely happy with the presentation; the teacher congratulates the four children who organized it and the classmates who helped. Before ending the session they form three groups in which to work on directional signs, maps, and room signs.

Sixth-grade students in Boulder, Colorado, proposed the construction of a bicycle path as one way of getting from their area into town. When they had gathered initial information on possible routes and costs, the students called the County Commissioner's Office to ask for a meeting. Following a presentation by the children, the commissioner listed what had to be done if the class were serious about their bicycle path proposal. The class then scheduled a presentation to the full panel of commissioners. To this meeting they brought petitions in support of a bicycle path, and their proposed routes. In addition, they presented background information on their activities and answered any questions raised by the commissioners. (See log by Thomas Dumler.)

Early in the next week the children meet in their groups to formulate plans, divide tasks, and begin their investigations. Children in the group working on directional signs compile a list of important places in the school. Their list includes the three locations already investigated, the school office, cafeteria, library, bathrooms, and gym. One child reminds them that since all the children in the school may use the signs, the starting points will not be the same. After a long discussion the group decides to put directional signs near the stairways and where two hallways meet. They also decide to post signs in the middle of the hallway on the lower floor where the kindergarten and first-grade classes are located. They decide to work on one major point at a time in order to compile the routes. Whenever they are not sure which is the best route, they agree to repeat the timing procedure used earlier. Once the routes are decided upon, they agree to use other students for their timed trials.

Students interested in posting room signs agree to include the name of the person whose room it is as well as what that person does or teaches in the room, for example, Mr. Daniels, Grade 2 or Ms. Stephens, Grade 3. As there are three floors in the school, the group decides to work on one floor at a time, starting with the floor their homeroom is on. They agree to meet in several days to discuss the sign design after they have counted the number of rooms on their floor.

Several members of the Map Group locate an old map of the school building which they bring with them to their first meeting. Other members of the group have prepared a rough sketch of their floor, which they also bring with them to the meeting. The children spend the first part of their session examining both documents and comparing them. Several discrepancies are noted immediately, for example, their own homeroom does not appear on the old map. The children decide to do a room count on their floor and to compare the number of rooms they count with the numbers that are represented on the old map.

> *A group of children in the Howell class worked on the construction of map racks for placement around the school building. They prepared ditto masters of existing maps and spent a considerable amount of time planning the construction and placement of the racks. (See log by Janet Sitter.)*

The children in the Room Sign Group meet to discuss the data they have collected. Several children report on the number of signs they need for their floor. When the numbers differ, several children comment that they did not count every room because some were already clearly marked. Other members of the group report that the room number system is very confusing because the rooms are not always numbered in order. They suggest that the issue be raised during the next class discussion, and the suggestion is accepted.

The child who was elected chairman of the group asks his co-workers how big the signs should be and of what they should be made. Several sample sizes are quickly drawn and cut out while the children discuss the material. After considerable discussion, the children decide that signs printed on pieces of oaktag paper cut six inches long by fifteen inches wide will fit on the doors and can be easily seen by people passing in the halls. Two students suggest that a different color of oaktag be used on each floor as another way to help people determine where they are in the building.

The Map Group meets after the room count has been completed to examine their data and plan their next action. They find that on their floor there are ten classrooms, a storage room, and two bathrooms; however, the map shows only nine classrooms instead of ten. Noting that the system is out of date and confusing, several students object to the present room numbers in the building. The teacher points out that the group working on room signs noticed the same problem and suggests that they raise the issue at the next class discussion. Before ending their group meeting, the children decide to pinpoint the discrepancies between the old map and present layout of their floor and use a tape measure to take any measurements necessary to update the original map.

Children in the Directional Sign Group meet to discuss the results of their timed trials. Once the median time is determined for each of the routes tested and the best route is selected, the children focus on the design, construction, and placement of signs. One student suggests using construction paper--a different color for each route, but a classmate points out that construction paper tears easily and will not last. Someone who heard that the room signs were going to be made out of oaktag suggests that the directional signs be made of it as well.

The group accepts this suggestion but adds that the routes should be color-coded. A classmate says that there should be writing on the signs. There is a lively discussion about the pros and cons of words versus color. Many feel that the signs should not have words written on them because many of the children who will be using them cannot read. A compromise plan is worked out which calls for signs that are color-coded by route with the name of the place to which they will direct you written on each sign. Several members of the group hold up sample signs they have made--arrows of different sizes. They are taped to the wall so that the children can see the alternatives and make a decision.

At the next class discussion, one person from each group is asked to report on his/her group's activities--progress, problems, etc. As the reports are given, the common concern with the room numbering system becomes evident. Many children report that they, too, have had difficulty locating rooms by room numbers. After considerable discussion, one member from the Map Group and one from Room Sign Group is selected to meet with the principal to see whether anything can be done. Before the meeting ends, the group of children working on directional signs ask their classmates to help them select a particular arrow size and color by voting for their choice. One child records on the chalkboard the number of votes each size gets. The 12" x 3" arrow gets the majority of votes--twenty-two out of a possible thirty-three. Before the session ends the class decides to use different colored signs for each route. The students agree that those children working on the signs should select the colors for each route.

During the next several weeks the children continue to meet and work in their groups. Several members of the Map Group report that they have found the differences between the original map and present school layout. One large classroom was divided into two classrooms three years before. One child says that there are probably other changes that would explain the difference between the old map and room counts that he had made on other floors. By asking the principal, they discover that rooms on other floors had been divided, that the wall between two small offices was removed to form one large office now inhabited by the school principal. During the renovating, a library was built in what used to be a large open area between the first floor classroom area and the gym. The children decide to schedule times to go to the rooms where structural changes have been made and take measurements to be used in updating the map, e.g., where dividing walls have been erected, placement of new doors, etc.

The next day the entire class is called together for a brief class meeting to hear the results of the meeting with the principal to discuss room numbers. The two children who spoke with the principal are very pleased to report that the problem has been brought to the principal's attention by several other people as well as their class and that action has been taken. The superintendent's office has directed the building office to renumber the rooms during the summer vacation. She suggests that the class put a new room numbering system on a copy of the updated map that they are preparing and send it to the building office. Before breaking up into their groups, members of the Directional Sign Group and the Room Sign Group announce that their signs are ready to be posted. They have divided the work among group members with the goal of completing their tasks by the end of the week.

The students in the Map Group bring their measurement data to their group meeting. Using the scale of the original map, they enter the measurement data on a copy of the map. One child raises the issue of the size of the map noting that it would be difficult to read an 8 1/2" x 11" map posted on a wall in the hallway. The rest of the group agrees and a discussion develops on what to do. Several children suggest making the map bigger, but no one knows exactly how this can be done. One child remembers using the "How To" booklet--*"How To" Use a Stopwatch*--and suggests that someone look through the "How To" Cards to see whether there is a set which would help them enlarge the map. Two students volunteer to look at the "How To" Cards before the group meets the next day.

The next day the two student volunteers excitedly tell their groupmates that they have located the necessary set of cards. Several copies of *"How To" Make Scale Drawings Bigger or Smaller* are distributed among the group. After reading and discussing the cards, the children agree to enlarge the map using graph paper. The children put a grid of one-inch squares on a copy of the map. While this is being done, several other children prepare larger graph paper by making two-inch squares on 18" x 24" paper. Using the "How To" Cards they transfer the map to the larger paper. This takes several group meetings to complete.

The Map Group shows the enlarged, updated map to the entire class during the next session. Their classmates and teacher are very pleased with the map. The class discusses where the map should be placed. The consensus is that one copy should be posted in the center hallway area of each floor in addition to one near the main entrance to the school. Members of the Map Group agree to make three more enlarged maps so that one can be kept in their room.

After making localized maps, the Brooklyn Kindergarten class made a map of their entire floor. Each room was illustrated, and the result was essentially a scale model of their floor. They also

> *drew routes showing how to get to the first grade rooms on the next floor and planned how to make a model of that area. (From log by Lorraine Shapiro.)*

At a class meeting held early in the next week, the groups report that their work is complete--directional signs, room signs, and maps have all been posted with the help of the custodian. The teacher asks the class how they can find out if their changes are making it easier for themselves and others to get from one place to another. Several students respond that the signs and maps have made a difference to them. Another child says, "But what about other people in the school?" One student suggests that they take a survey. The teacher asks if everyone knows what a survey is and explains it to the class when some children say that they do not know. The children spend a great deal of time discussing the size and makeup of the survey sample. They agree that their changes were originally aimed to help themselves and other children in the primary grades get from one place to another; therefore, they decide to survey all first-, second-, and third-grade classes in the school, themselves included--a total of nine classes.

> *Fifth-grade students in Washington, D.C., complained that construction and building repairs made it very difficult to get around the school. Because routes were changed often, there were accidents on some of the stairways. They decided to conduct a survey of two classes from each level to determine which areas posed the greatest difficulty. After graphing the results, they broke into three groups to work on the three most important problem areas. (From log by Helen Nesbit.)*

> *Sixth-grade students in the Boulder class decided to survey their schoolmates to determine whether or not other children were interested in their two proposals--a bicycle path and bus transportation into town. The survey questions were prepared, and children practiced administering the survey on their classmates. The students worked in teams both scheduling and administering the survey. (See log by Thomas Dumler.)*

The next day the class meets to decide on the survey questions. Several students remind their classmates that the survey should be short so that the children won't get bored and stop paying attention. The five questions selected for the survey and the totals for each questions are shown below.

1. Have you seen the signs and maps which are posted around the school?

   yes 230 no 30

2. Have they helped you get from one place to another in the school?

   yes 227 no 33

3. Which ones have helped you?

   directional arrows 156
   room signs 200
   maps 85
   none 30

4. Could they be better?

   yes 76 no 184

5. How?

   The room signs should be lower 70
   The arrows should be closer together 36

The children have some difficulty deciding how to administer the survey. Some children want each child surveyed to have his/her own copy while others suggest that it be administered to the classes orally by pairs of students. The children in favor of the second proposal argue that many of the children in the lower grades won't be able to read the questions. They convince the class that the survey should be administered orally.

One student volunteers to write the survey questions on a duplicating master, and the teacher agrees to make eighteen copies. Eighteen children volunteer to administer the survey. They decide to work in pairs with each pair surveying two rooms. The children practice what they will say in the classrooms, and their classmates listen critically and make suggestions of ways in which they can improve their delivery, e.g., speak louder, speak slower, pause between questions. Each pair of children is instructed to ask for a show of hands for each question, to count the votes, and to record the numbers on the survey sheet labelled with the name of the classroom teacher.

Two days later the class meets to tally the survey data. The figures are written on the board, and the third-grade children help the second graders in computing the totals which can be seen on the previous page. The class decides to make bar graphs of the answers to the second and third questions and post them in the hallway for all interested schoolmates to see. They ask an upper-grade class to help them with the scale for the graphs. After seeing the graphs, the children happily agree that the data proves that their changes are making a positive difference and decide to make the suggested improvements.

> *One sixth-grade class in Ocala, Florida, decided to work on four areas--identification of portable classrooms, directional signs, a sidewalk plan, and a school directory. (The directory group was subsequently absorbed by the others.) The two sign groups complete and pasted their identifying signs and their directional signs. The sidewalk route group found their task was large but eventually finished it successfully by working on their own and with another class. (From log by Donald Werhner.)*

6. QUESTIONS TO STIMULATE FURTHER INVESTIGATION AND ANALYSIS

- Do you have trouble getting around the community? the school?
- Are places clearly marked?
- Are directions available?
- How do you get around the community?
- How do you feel when you get lost?

- How could you find out whether others have trouble getting around the school?
- How big should your sample be?
- How should you pick your sample?
- Will the answers you get from your questionnaire really tell you what you want to know?
- What can we do to make it easier for to get around the school or community?
- What information do we need?
- How could you organize yourselves to best collect the data you need?
- What is a good way to keep a record of your data?
- How can you make a picture of your data?
- What does the range of your data tell you?
- What does the median of your data tell you?
- What will help you convince other people that your proposals will help?
- What plans need to be made for carrying out your proposals?
- How can you find out if your changes make it easier for people to get around the school and/or community?
- What can you do to make your solutions better?

C. Documentation

1. LOG ON GETTING THERE

by Michael McCabe*
Hardy School, Kindergarten
Arlington, Massachueetts
(November 1974-February 1975)

ABSTRACT

This class of kindergarten students in Arlington, Massachusetts, began work on the Getting There challenge after they were unable to find their way to the school library. They prepared directions and tested them only to find that they were inaccurate. The children prepared maps of the route they thought would get them from their room to the library. They were introduced to different ways of measuring and selected pacing as a means of determining the shortest of their proposed routes. Their investigation of the challenge ended with a discussion of what the "best" route meant--shortest amount of time, shortest distance, safety, or familiarity.

My kindergarten students began investigating the Getting There challenge after a discussion of the children's trips to the school library. The children were going to the library once every other week, but they really did not understand where it was nor how they got there. An initial discussion of how to get to the library produced several suggestions which included (1) on tip-toe, (2) quietly, (3) upstairs. The entire class took a trip to the library with the children leading the way.

The directions recorded below were given by the children en route to the library:

> Forward, backwards, then forward by two stairways to the end of the corridor, then left (to another dead end), then downstairs (instead of up), then across the whole building to another set of stairs, then up across the building again to another set of stairs and down.

They eventually found their way back to the classroom but never found the library. We talked about why the class never reached the library; the children acknowledged going the wrong way. A group of students interested in drawing maps of how to get there began work as the USMES class session ended. They continued to work on their maps later in the day. Examples of their work can be seen in Figures C1-1 and C1-2.

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*Edited by USMES staff

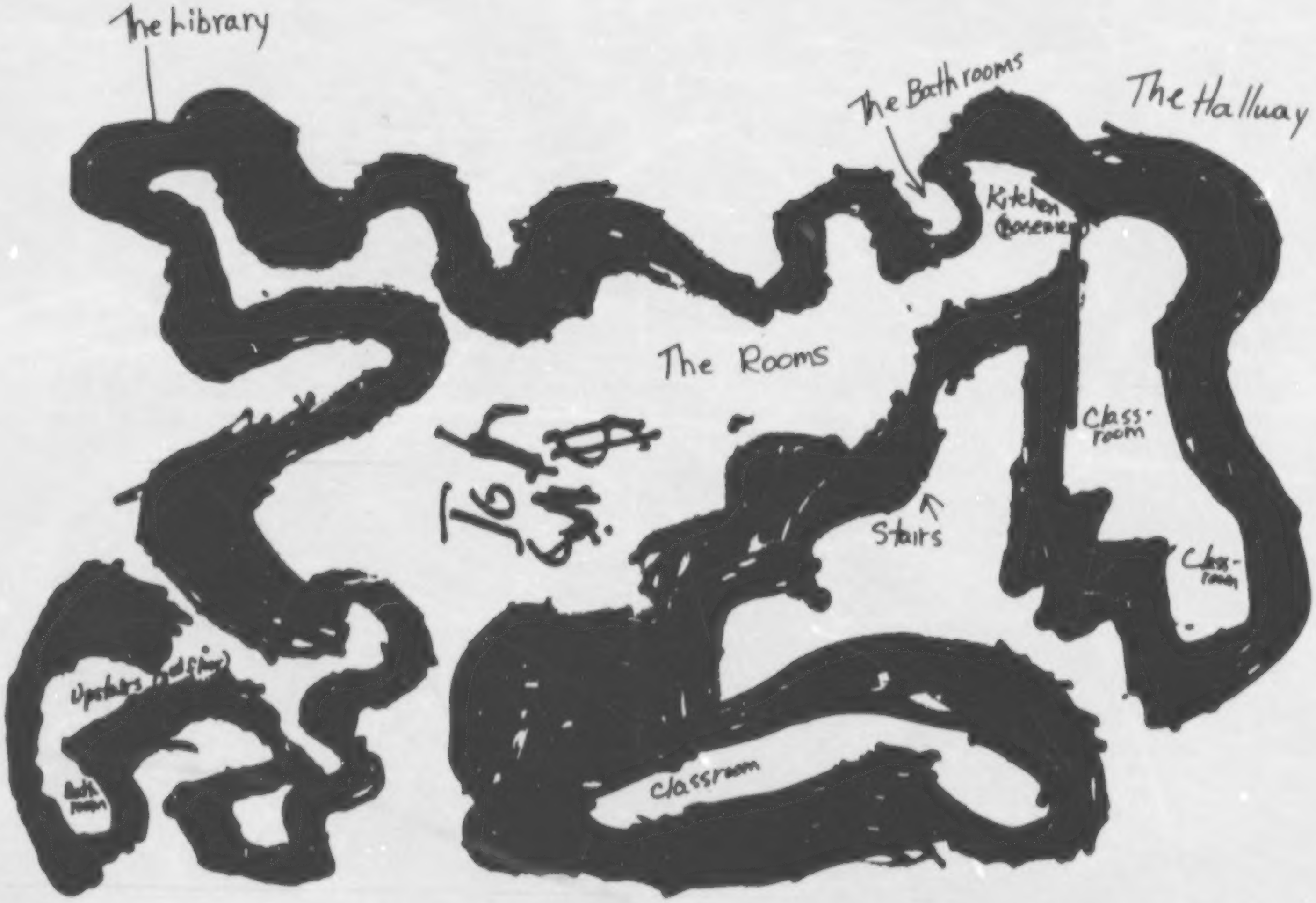
The Library
The Bathrooms
The Hallway
Kitchen (basement)
The Rooms
To the Gym.
Class-room
Stairs
Class-room
Upstairs (2nd floor)
Bath room
classroom

Figure C1-1

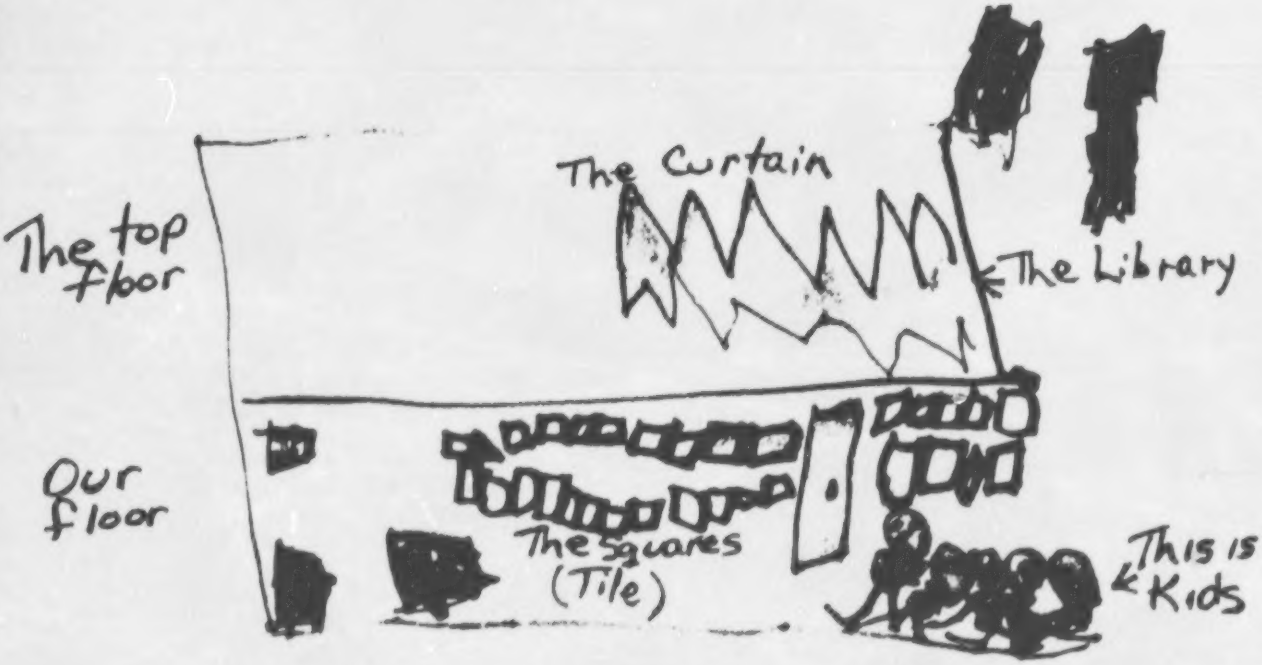

Figure C1-2

During the next class session, we discussed our attempted trip to the library and the possibility of finding more than one way to get there. One of my students reported that he knew a different route than the one tried yesterday: "We can go up--not down like yesterday." With Paul in the lead, we went on a successful round trip excursion to the library.

After acknowledging that there is more than one way to reach an agreed-upon destination, my students began talking about comparing several ways and determining the best or shortest route. The challenge I presented to the class was, "Find the shortest way to the library." The children's initial response was that, "Everybody knows the shortest way." I challenged them to prove it. Each child felt that his/her way was the shortest. The students focused on how to prove something. I asked them how they could prove they were strong and they responded, "By lifting weights." To the question of finding the tallest person in the room, they

responded, "**Measure**". With the connection verbalized, the children decided to measure different routes to the library from our classroom. Two measuring instruments were suggested--a ruler and a scale. The scale was soon discarded as being inappropriate for their purpose.

Using a ruler, the students tried to measure the route to the library. They soon discovered that they needed to learn more about measuring before they could proceed any further. We returned to the room where the children began to measure anything in sight, including the gerbils, with a one-foot ruler. Several children put two one-foot rulers together to measure larger items. The children tried to measure the length and width of the classroom with a one-foot ruler; they had difficulty and decided, instead, to try the fifty-foot tape measure that just happened to be in the room!

My students became very interested in measuring. From the beginning of the unit, we explored measuring instruments including the use of arbitrary units of measure, e.g., fingers, arms, body length, to measure distance. Through trial and error, the children became better able to match an appropriate unit of measurement with the item to be measured, for example, body length to measure the width of the room, finger length to measure the length of a book.

During one class session, I introduced the idea of measuring distances by pacing. The children worked in pairs with one child pacing while the other counted the number of paces. There was some difficulty with the counters not being able to keep up with the pacers!* They began by pacing the dimensions of the room and moved on to pace the length of the nearby hallway before tackling two different routes to the library. One problem was that everyone wanted a turn to be the "pacer" which resulted in inconsistant data due to different leg lengths of all the children. We spent some time discussing the need for one person to do all of the pacing.

When the children felt that they had spent sufficient time practicing, a pacer was selected and we paced the distances of two routes to the library. In both cases the

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*The children might try dropping a block in a bag for each pace taken, then counting the blocks later when there is more time. --ED.

children decided to discount the stairs from our room on the first floor to the library on the second floor. One route took 200 paces while another required 196 paces. The children returned to our room to discuss the data we had collected. They compared the two numbers and agreed that 200 was "bigger" than 196.

Many students felt that even though one route was travelled in fewer paces than another, the longer route was better. I questioned what they meant, and they responded that "best" did not have to mean shortest. Several students preferred the longer route because it was familiar. Other children agreed, observing that they often took longer routes from home to school because they wanted to see a particular place or avoid something, for example, passing a classmate's house or avoiding an unfriendly dog.* The children agreed that their investigations had helped make them more comfortable with their surroundings.

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*The children might discuss whether this information might help other students in the school or students who would be coming for the first time the following year. The class might make a map of the area showing locations of stores and other interesting places as well as streets with heavy traffic and other things to avoid.--ED.

2. LOG ON GETTING THERE

by Natalie Palmer*
Thompson School, Grade 1
Arlington, Massachusetts
(September 1974-October 1974)

ABSTRACT

Students in this first-grade class worked on the Getting There challenge of helping themselves and other kindergartners and first graders find their way around the school. They prepared maps of the wing in which their room was located and formulated directions to follow from their classroom to other rooms in the school. In addition, they posted directional signs in the hallways to help children get around the building.

My students became interested in the Getting There challenge while discussing their social studies unit, "All Around Me," and talking about children in school. The poster they were examining depicted children of different sizes walking to school. My students tried to guess the grade levels of the children pictured and whether or not that grade level was contained in our school. This naturally led to a discussion of the rooms contained in our school building and whether or not the children thought they could find their way to them and back, e.g., the library, the office, the clinic, room 20.**

I challenged my students to find ways to make it easier for them and kindergarten children to find their way around the school. The three suggestions immediately offered in response to the challenge were (1) to look all over, (2) to take pictures of the school and to show them to people, and (3) to make a map. Most students thought that making a map was a good idea. The class agreed to begin their project the next week.

During the next class session the children grouped to talk again about finding their way around school. We spoke of the maps each of us had seen and of other things that help people find their way. The children voted to determine which project they wanted to begin and map-making was selected. (The results of the vote can be seen in parentheses next to each suggestion.) The items mentioned are listed below:

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*Edited by USMES staff

**The children in older classes might focus on providing information on the best way to get to school from various locations in the community.--ED.

1.	map	(9 votes)
2.	ask someone	(2 votes)
3.	show someone	(3 votes)
4.	signs	(5 votes)
5.	arrows	(5 votes).

Next, the class formulated a list of materials that would be needed consisting of the following items:

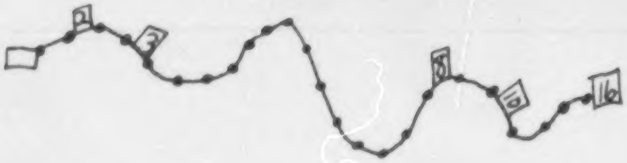
1. crayons
2. a stapler
3. paper
4. pencils
5. tape
6. paint.

The children gathered the materials and decided to begin with pencil and paper. Several students went right to work; most, however, did not know how to make a map. I felt strongly that I did not want to intervene at that point, so I just encouraged them to "do what they thought." The children were very involved in the project--sharing ideas, asking questions, exploring the school. When the individual maps were completed, each was displayed and discussed by the class. I wrote down the children's ideas as taken from the individual maps, to be used on a bigger class map. Their ideas are listed below:

1. numbers on doors
2. arrows
3. shape of the room
4. shape of the halls
5. "being right"
6. showing dots to follow.

Four sketches of their individual maps can be seen on the next page.

(A)



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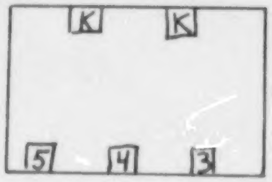

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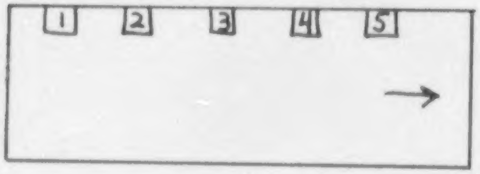
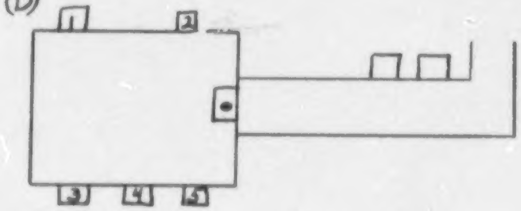


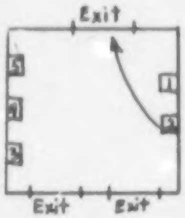
(D)



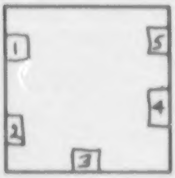
Many of the maps were of the A wing which housed the kindergarten and first-grade rooms. A few of them showed the nurse's room and the office down the hall (sketch D). Although all the students were pleased with the individual maps they had prepared, it was clear to us that they were at an impasse.

We began the next class session with a discussion of the first set of maps. Several students suggested going out of the room and starting a school map, but most preferred making a second set of individual maps. With paper and pencils the class went out into the A wing hall, which also served as a playroom, and walked around noticing the door locations, numbers, and "EXIT" signs. Someone said that it would be important to draw windows and the firebox.

The children gathered back in the classroom and made a second set of individual maps of wing A. Seven children displayed a very good understanding of maps. Of these seven students, several drew an arrow from Room 2 (their room last year) to the hall exit. This was done to show the kindergarten children how to get to the hall. (See sketch below.)



Another seven students displayed some understanding of maps but had difficulty determining directions; for example, three put all the rooms in a row while two put them on all the walls, and others had the room numbers mixed up. (See sketches below.)



Two children were able to include only parts of the room, e.g., exits only, and four students did not make maps--they wanted to watch.

In an attempt to expand the focus of the children's investigations I began the next session by asking the children to find their way to the Design Lab using my directions, e.g., "go up there," "go up five stairs." Over the next several days we explored different parts of the school as the need arose, e.g., delivering notes, going to the office.

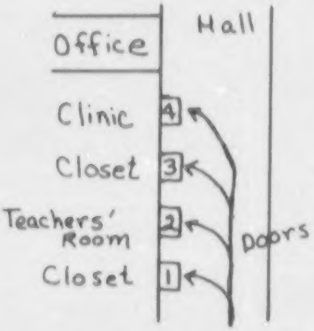
One of my students cut her knee and had to go to the clinic for first aid. Usually this is no problem for the children; however, Kathleen said she did not know where it was. I asked someone to give her directions. Several children volunteered instructions.

"It's the room down the hall."

"Just before the office."

"Second door on the left."

Kathleen returned feeling much better, but she said that the clinic was not the second door. One student went to count the doors; he returned to announce that it was the fourth door. We drew the following map on the board:

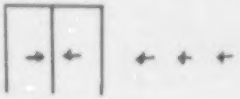


Since we were planning a visit to the Title I room the following week, a student who was familiar with the room gave directions to the class. I wrote down his directions (listed below) as he dictated them to me, and we brought them with us. The children followed as I read the instructions phrase by phrase.

Go through the hall.
Turn left.
Go past Mrs. Lee's. (the library)
Go through the swinging doors.
Go down the stairs.
Go through the other swinging doors.
Turn right.
Go into a door. That's it.

We found the room easily. The children agreed that their classmate's directions were good. They did note that the first direction was not clear, that is, the hall that was being described.

The children made arrows to use in halls to show kindergarten children the way to the Design Lab. Some wrote "Go" on them before they were taped to the walls. Students felt this was an effective way to help the younger children find their way around the school and decided to expand the use of directional signs in the school. One child questioned how the kindergarten children would find their way back to their room. A classmate responded that they would just follow the arrows back. This seemed to satisfy the class. The children found that group work was more efficient than individual work on the production and display of the arrows: one group of students made them while another group taped them to the walls in the proper direction. Two arrows facing each other were used to indicate that students should go through a door. (See sketch below.)



Arrows were used to mark the route to the kitchen taken by kindergarten classes.* Students in my class went to the kindergarten classes to explain how to follow the arrows.

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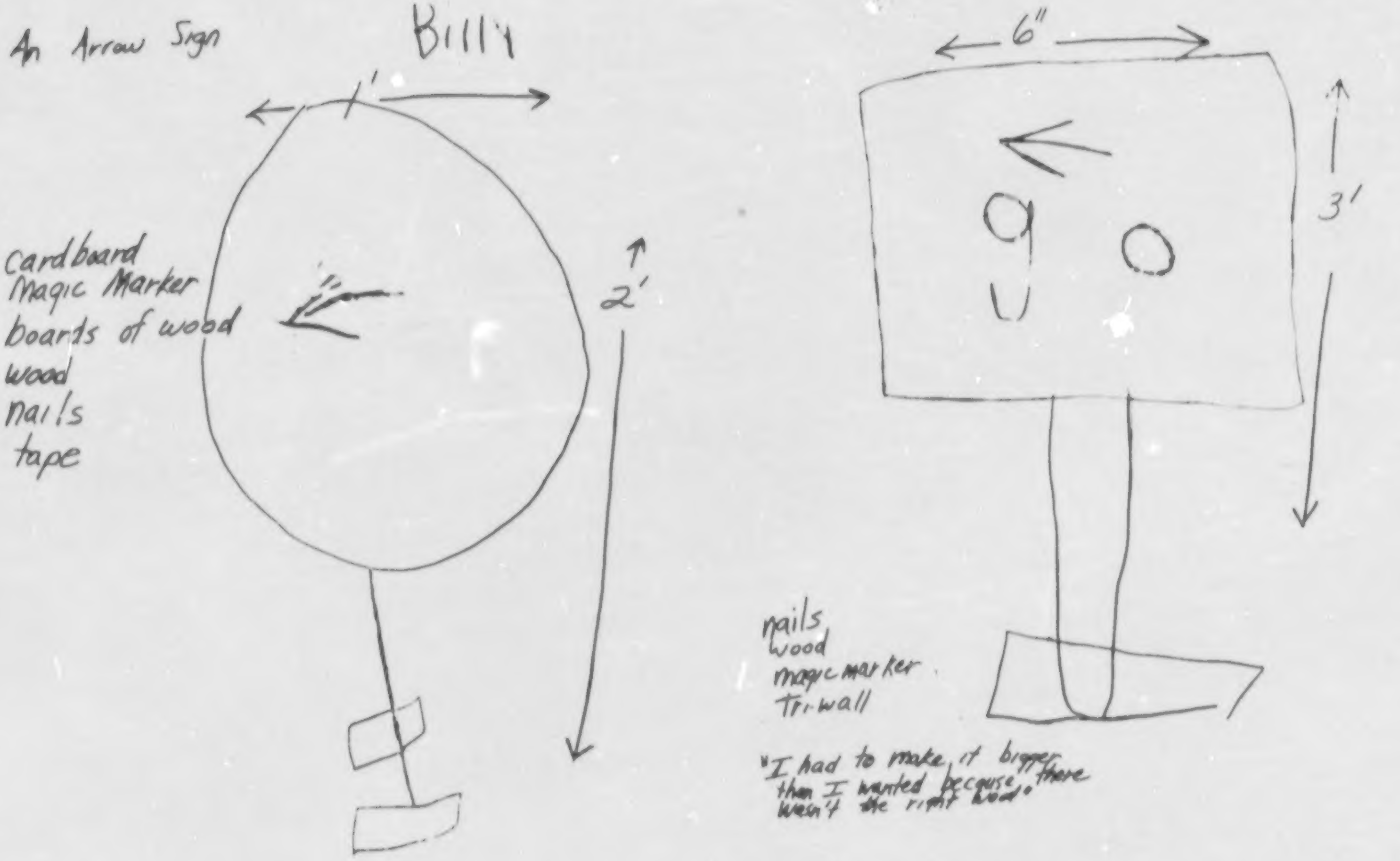
*The children might discuss whether two sets of arrows would be confusing. They might decide to color code the arrows with signs indicating what the colors meant.--ED.


An Arrow Sign
Billy
1'
2'
cardboard
Magic Marker
boards of wood
wood
nails
tape
6"
3'
go
nails
wood
magic marker
Tri-wall

"I had to make it bigger than I wanted because there wasn't the right wood."

Figure C2-1

Feedback from teachers indicated that the arrows were helpful and that children were able to find their way both to and from the kitchen. A problem developed when older children took down arrows and bothered the younger children. My students tried replacing the arrows and posted a sign asking that no one take the markers down. When the younger children were familiar with the route, the children in my class took down the arrows.

A later aspect of the unit was to provide the service of helping children find their way to different parts of the building as the need arose. Triangular paper signs were used to mark the route to the office, and bottle-shaped paper signs were used to mark the way to the nurse's office. Students used the Design Lab to construct large directional signs out of Tri-Wall and wood. (See Figure C2-1.) The base of the signs that were constructed were too small; the result was signs that were unable to stand by themselves. The student who built them returned to the Design Lab and corrected his error.

3. LOG ON GETTING THERE

by Janet Sitter*
Michigan Avenue Middle School
Grade 5
Howell, Michigan
(November 1974-June 1975)

ABSTRACT

This incoming fifth-grade class in Howell, Michigan, had a lot of trouble getting around Michigan Avenue Middle School. To help the next incoming class, these students worked on Getting There for seven months, averaging two to three thirty-minute sessions per week. They listed hard-to-find locations in the school and gave reasons that these places caused difficulty. To determine the extent of the problem, the children surveyed all fifth-grade classes and found that an overwhelming majority had difficulty getting around. After suggesting solutions, the class broke into groups to develop and test some of these recommendations, which ranged from putting footprint-shaped signs on the floors to building a mechanized traffic man. To quantify the extent of the problem, students invited fourth graders from an elementary school to participate in a room-finding experiment. The children timed the visitors as each tried to find three specific rooms and then averaged all the times for each room. Each group implemented a proposed solution, selected three of the six tested rooms, and timed a new sample of fourth graders. The class decided to accept the solution of the group that showed the most improvement over the initial data. After analyzing the results of every group, the class recommended to the principal that directional signs be put up on the walls throughout the school to enable people to locate any room. The principal agreed and allowed the class to prepare the signs and to put them up before the next school year.

I began by asking my students whether they had trouble finding their way through the school. After their vigorous affirmative response, I asked them why they had trouble. Because the school was so large, they agreed, having come from very small K-4 schools. Most of the children had forgotten the ten-minute building tour they received in June.

The children enthusiastically felt they could do something to help the fourth graders find their way around the school next year. We listed on the board the following trouble spots that made getting around difficult:

---

*Edited by USMES staff

1. the double rooms
2. Mrs. Hable's room
3. stairways
4. Mrs. Bergin's room
5. buses
6. bathrooms
7. gym
8. art room
9. office
10. coming back into school from the portables
11. principal's office
12. music room
13. nurse's room
14. lockers
15. library
16. counselors' office
17. teachers' lunchroom
18. book room
19. custodian's office

In an active discussion to determine why each item caused difficulties, the children named bathrooms as the most troublesome item and explained that no one told them which bathroom to use when they weren't in their homeroom. Stairways gave them trouble because the children had come from one-story elementary schools. They said they often didn't know which floor they were on this year.

A student began the third session by restating the challenge: "Can we find a better way to help students find their way around this school?" When I asked whether they had trouble finding their way in other things, the students offered these situations:

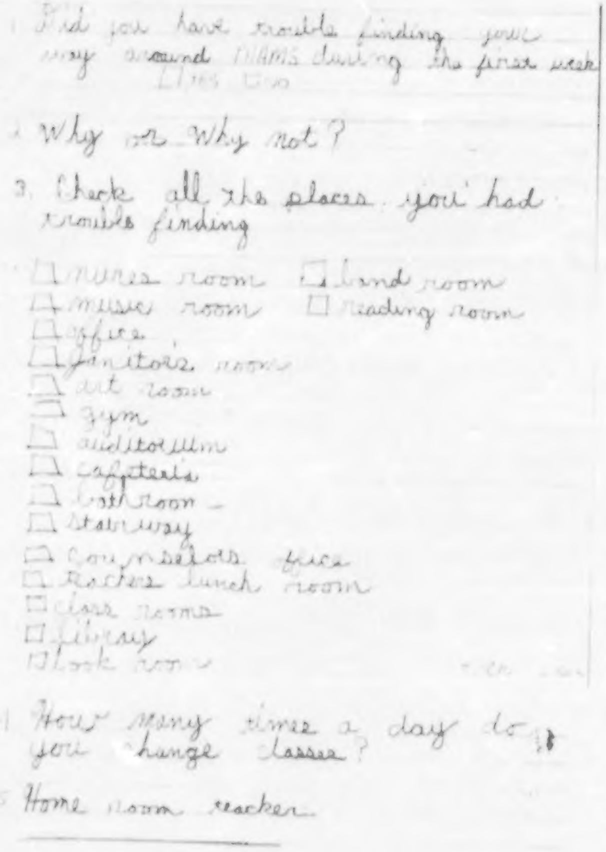
1. places--finding your way from one place to the next or to a place you haven't been before

2. books--finding the right books for the right class and knowing when to go back to the locker to change books

3. schedules--understanding for the first time how to change classes every fifty minutes.

The discussion turned to some students who said they didn't have trouble finding their way anywhere in the school. Explaining that we would time them, I sent three of these students in a group to find room 333 as quickly as they could. I gave them a note for the teacher in 333, requesting her signature so that the group could show evidence of finding the room.

The long time (five minutes) for the round trip to the room--one floor above and directly across from our room--resulted from the roundabout route they took getting there. "Some rooms don't even have numbers!" one exclaimed. The



1. Did you have trouble finding your way around MAMS during the first week
☐ Yes ☐ no

2. Why or Why not?

3. Check all the places you had trouble finding

☐ nures room
☐ music room
☐ office
☐ janitors room
☐ art room
☐ gym
☐ auditorium
☐ cafateria
☐ bathroom
☐ stairway
☐ counselors office
☐ teachers lunch room
☐ class rooms
☐ library
☐ book room
☐ band room
☐ reading room

4. How many times a day do you change classes?

5. Home room teacher

Figure C3-1

students took a direct route coming back "because we knew the way then."

We sent out two more groups: one to count the number of boy's bathrooms in the school, the other to count girl's bathrooms. Each group was astounded to learn that they had found only about half of the existing bathrooms.

Was our class of twenty-nine fifth-grade students unique in having difficulty finding places in the school? The class said that all of the other 270 fifth graders also have trouble. They based this assertion on talks with friends and among themselves and on observation of lost students wandering the halls.

To show that getting around was a problem for most fifth-graders, the children decided they would need proof that the majority had trouble finding their way. (The class carried over this concept of majority rule from our recent work in social studies.) They suggested the following ways to gather the required data:

1. Ask all fifth graders during lunch to raise their hands if they had trouble finding their way at Michigan Avenue Middle School
2. Have some of us in the lunchroom asking the fifth graders and marking down their responses
3. Have a voting booth outside the cafeteria for fifth graders to vote after lunch
4. Have some of us go around to all the fifth-grade rooms and ask

The students favored the voting booth idea, but when I asked whether they knew about surveys, they said no. I then explained surveys by choosing examples from TV commercials, and the class decided to take a survey of all fifth graders in the school. (I should have let my students pursue the voting booth idea and discover for themselves its impracticality, but to save time and adhere to the original challenge, I directed them toward surveys.)

After the children decided which questions to include in the survey, one student wrote them on a ditto (see Figure C3-1) for copying and distribution. The class offered these suggestions for conducting the survey:

1. Bring survey forms to classrooms and wait for students to complete them
2. Bring forms to classrooms and leave them there
3. Outside the lunchroom, ask the questions and keep a tally
4. Inside the lunchroom, write the results as fifth graders vote
5. Distribute the forms in teachers' mailboxes; have teachers ask their students to fill them out

The best and quickest of the methods, the class decided, was to bring the forms to classrooms and wait. This technique would also allow time for explaining to students the purpose of the survey and for answering questions.

After conducting the survey, the students tallied the results and discussed them question by question.

Question 1. Did you have trouble finding your way around Michigan Avenue Middle School during the first week?

147 - YES 100 - NO

One boy doubted the accuracy of the totals for the first question, pointing out that, of the one hundred people who said they did not have trouble, seventy-one checked off in the third question places they had difficulty finding. He suggested we subtract those seventy-one responses from the NO column and add them to the YES column to be "more right." After a minute of total silence, the class agreed and changed the tally to 218 - YES, 29 - NO. The students concluded from the results of the first question that the majority of fifth graders had trouble in September and that we should do something to solve this problem.

Question 2. Why or why not?

Most of the "why nots" wrote about having older brothers, sisters, or friends in the school who helped them. The "whys" gave reasons similar to those given by my class:

1. big school
2. too many rooms
3. not used to changing classes so often
4. so many special rooms (art, music, counselor, nurse).

Question 3. Check all the places you had trouble finding.

After adding the checks that each item received, the children decided to rank them to see which places caused the most problems.

Rank	No. of Checks	Place	Rank	No. of Checks	Place
4	115	Nurse's Room	12	50	Bathroom
6	103	Music Room	12	50	Stairway
6	103	Office	9	69	Counselor's Room
3	125	Janitor's Room			
13	46	Art Room	10	65	Teachers' Lunchroom
11	64	Gym			
2	127	Auditorium	1	161	Classrooms
12	50	Cafeteria	8	75	Library
7*	96	Reading Room	6	103	Book Room
			5	111	Food Room

The students noted that "band room" had been incorrectly copied onto the ditto as "food room." They then assumed that people who took the survey must have thought that food room meant the place where they ate, so the students chose to add the food room and cafeteria numbers, making a total of 161. They also decided to work first on the five highest ranked rooms.**

Question 4. How many times a day do you change classes?

---

*The Reading Room could also be ranked ninth because three rooms tied for sixth. There would be a corresponding shift in the remaining rankings.--ED.

**The children might discuss how to make their data more meaningful to others. Possibilities are (1) to reorder list according to rank order or (2) to make a bar graph of the data.--ED.

The students had put this question in the survey because they felt that those changing one or two times would have less trouble than those changing four or five times. They found that everyone changed at least three times daily and the number of changes didn't relate to amount of difficulty; locations of rooms involved in the changes mattered much more. For example one group--which went only across the hall and next door for class changes--didn't have problems, even though they changed five times per day. One group that had trouble made only three changes daily; they travelled from one end of the building to the other via the outside portables.*

Question 5. Home room teacher.

By including this question to cover unique problems that might arise, the class had shown foresight. One teacher returned her students' surveys with correct grammar, punctuation, and spelling. My class doubted the credibility of these responses. The children also noticed that a large majority of another class responded NO to the first question but checked off two or more items in Question 3. Upon examining answers to the "why not" question, my class discovered that all gave this identical, correctly spelled reason: "Our teacher took us around and showed us where everything was." My students placed this batch in the special group for questionable data.

Returning from the holiday vacation, the class began the new year by focusing on solutions to the problem. They sought the quickest and easiest method to direct traffic through the school and suggested the following techniques:

1. Color code--make a chart showing the door color of each room and place it at building entrance
2. Coded symbols--put a symbol or picture on each door and place a chart showing these symbols at building entrance
3. Teachers' names--put the name of each teacher on the outside of his or her door

---

*If the students want to present this lack of correlation to others, they might make for each location a scatter graph of the number of changes each class makes vs. the number of students in that class having trouble finding that location.--ED.

4. Signs on walls--make arrows or footprints that students can follow to the room they wish to find

5. Charts--include names, homeroom numbers, etc., of teachers on charts and hang them on walls near exits

6. Map--make giant maps of the floor plan of the school showing names and rooms of teachers and hang maps near exits

7. Traffic man--make a five-foot tall cardboard man with a dial in his stomach; as a lost student turns the dial to the desired room, a corresponding dial would show the directions for getting there

8. Map rack--place a box near each exit to hold dittoed maps of the school

9. Room numbers--simply put room numbers outside the rooms (At Michigan Avenue Middle School, rooms have been renumbered so often that some rooms have two or three numbers, some have no numbers, and some have wrong numbers.)

10. Code numbers--renumber the rooms in a simpler, more logical sequence

11. Graders--locate all fifth-grade rooms on first floor, sixth-grade rooms on second floor, and seventh-grade rooms on third floor

12. Computer machine--pulling a knob labeled with the teacher's name would release a card with directions

13. Talking tape--at each exit, place a tape recorder that would give directions to every room in the school

The class chose to follow through on several of these ideas (which I will discuss later) and divided into appropriate groups. Before completing their group projects, however, the class decided to collect data on the amount of difficulty newcomers would have getting around in the school.

We discussed having the fourth graders from South East Elementary School take part in data gathering. The class decided to time the visitors as they tried to find the rooms listed on the survey.

We then began to group together rooms that were similar in nature, with the thought that, in such a group, you could find one room as readily as another. After much active discussion, sorting, and sorting again, this final grouping evolved:

* counselor
* nurse
* office

reading room
# library

= cafeteria
= auditorium
= home economics

+ band
+ music room
+ gym
+ art

@ bathroom
@ janitor

* places that help people, places to go if you need help
# places to go to read or to get help in reading
= places to eat or to find someone who is eating
+ places to do other things besides school work
@ extra places

There followed a long and lively discussion to select the representative room for each category. After listening to all arguments, the students voted with these results:

* counselor
# library
= cafeteria

+ gym
@ bathroom

Adding our room (229) to the list made six places we would ask our visitors to find. With six destinations and three possible starting points (entrances), the class decided that we should invite six fourth graders to participate. At this point organization became complicated as we faced these questions: Who would be assigned to find what? How many trials? Who would do the timing? Eventually we drew up this chart:

Participants	Entrance	Place to Find	Timer
		First Set of Trips	
1.	A	room 229	
2.	B	"	Dawn
3.	C	"	Freddy Mc
4.	A	counselor's office	Jackie
5.	B	"	Sue
6.	C	"	Alan
		Second Set of Trips	
1.	A	cafeteria	Cathy
2.	B	"	Nigel
3.	C	"	Mark W.
4.	A	library	Davey
5.	B	"	Freddy C.
6.	C	"	Mike M.
		Third Set of Trips	
1.	A	gym	Annette
2.	B	"	Greg
3.	C	"	Mike B.
4.	A	bathroom	Jim
5.	B	"	Penny
6.	C	"	Dick

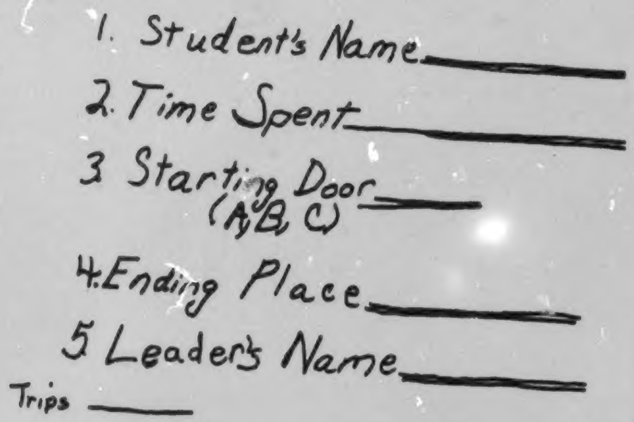

1. Student's Name______
2. Time Spent______
3 Starting Door____ (A,B,C)
4. Ending Place______
5 Leader's Name______
Trips ____

Figure C3-2

A student designed and duplicated a form on which timers would record their data. (See Figure C3-2.)

On the morning of the day scheduled for the experiment, we quickly reviewed each student's responsibility and location. Of the nine students not involved in timing, we planned to station six at the final destination rooms and the other three with me to act as hall monitors. Although we went to lunch in seeming disorder, my students took charge of our visitors when they arrived that afternoon, and the activity proceeded smoothly.

The next day we concerned ourselves with what to do with the collected data. We devised the following chart to display our results:*

---

*Throughout this log, times are indicated by minutes: seconds; e.g., 10:30 means 10 minutes and 30 seconds.--ED.

NAME	DOOR	GYM	COUN.	CAF.	229	LIB.	BATH.
1. Cheryl	B			:40	3:00		1:11
2. Don	B	:15	5:00			1:13	
3. Ronnie	C	15:02	:18			:35	
4. Jeff	A	:20		:15	never found		
5. Sharon	C			3:45	3:30		2:28
6. Lori	A		:12			:21	2:40

Because we had only three trials for each room, the class decided to invite six other fourth graders and run a similar session.* They did so, and again the activity ran smoothly, yielding these data:

NAME	DOOR	GYM	COUN.	CAF.	229	LIB.	BATH.
1. Julie	C	7:15		4:03			:20
2. Nadine	A	1:19			6:15		4:06
3. Danny	B		5:30	4:12			
4. Marty	A	:15			2:12	:20	:35
5. Tracie	B		:25		10:30	1:00	
6. Fred	C		:25	:38		6:05	

With two timing sessions under their belts, the students turned to analyzing their information. To account for some of the very short trip times, students suggested these factors:

1. Some rooms can be easily found from some doors.

---

*Because this still yields only two trials for each door-to-room combination, the children might discuss whether this is a big enough sample.--ED.

2. During their first trips, some fourth graders passed rooms they would be asked to find on their second or third trips.

3. Some rooms were very obvious.

The students mentioned some items they found interesting:

1. Everyone took a long time to find room 229.

2. One girl passed the cafeteria at least six times without identifying it, even though the sixth grade was having lunch at the time and making quite a racket.

3. Most of the participants, if they were at MAMS, would come to classes late.

During this review, the class saw only the data from the second running of the activity. They couldn't remember the first set of times, and so they asked to see all the information on one chart.

NAME	DOOR	GYM	COUN.	CAF.	229	LIB.	BATH.
1. Cheryl	B			:40	3:00		1:11
2. Don	B	:15	5:00			1:13	
3. Ronnie	C	15:02		:18		:35	
4. Jeff	A	:20		:15	X		
5. Tracie	B		:25		10:30	1:00	
6. Sharon	C			3:45	3:30		2:28
7. Lori	A		:12			:21	2:40
8. Julie	C	7:15		4:03			:20
9. Nadine	A	1:19			6:15		4:06
10. Danny	B		5:30	4:12			
11. Fred	C		:25	:38		6:05	
12. Marty	A	:15			2:12	:20	:35

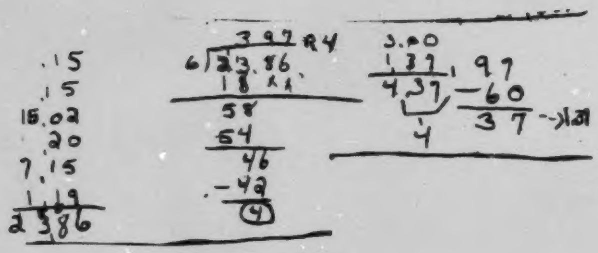


Figure C3-3

Noticing differences among times for the same room, the class attempted to find one representative number for each room. Some students suggested the middle number (median); some, the longest number; and some, a number in between. "If it took one student ten minutes and another student five minutes, couldn't we use seven minutes? Then the one student gained two minutes and the other lost three minutes," said one boy, who then became upset when he realized the numbers didn't balance.

I explained averages to them, and the students said they would like to use such numbers. Together we calculated two of the averages, then the students by themselves attacked the remaining figures with a new-found eagerness for math.

"I had better learn to divide so I can do this stuff," one child muttered to herself.

They found the average time for each room (many times over) and then had to convert the units from seconds to minutes and seconds (see Figure C3-3). The class--having more trouble grasping the concept than the process--obtained these results:*

Gym	4:37
Counselor	2:18
Cafeteria	2:09
Bathroom	2:13
Room 229	5:37
Library	1:49

Our room (229) proved to be the hardest to find, the students concluded, suggesting these reasons:

1. Some rooms lacked numbers.
2. Teacher's names did not appear on doors.
3. Even when the fourth graders found room 229, they weren't sure they had found the right one; nothing indicated the room number.

The class also accounted for the easiest room, the library, by saying that the bulletin board displays in the hallway around the room made it simple to identify.

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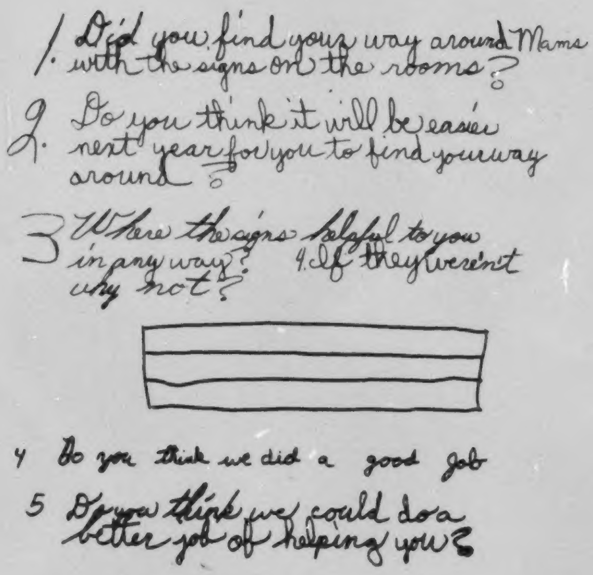
*Some of the groups had trouble adding and/or dividing minutes and seconds thereby obtaining incorrect averages. The teacher might consider giving a skill session on operations using minutes and seconds.--ED.



1. Did you find your way around Mams with the signs on the rooms?

2. Do you think it will be easier next year for you to find your way around?

3 Where the signs helpful to you in any way? 4. If they weren't why not?

4 Do you think we did a good job

5 Do you think we could do a better job of helping you?

Figure C3-4

After analyzing their experiment, the students returned to their group projects (listed below), which they had begun earlier:

Group Projects

1. signs on walls
2. signs on doors
3. traffic man
4. color-coded chart
5. map rack
6. feet on floor (changed from computer machine)
7. room numbers

Each group discussed plans for making the object(s) they needed, suggesting and then accepting or rejecting preliminary ideas. Social dynamics within each group centered on these issues:

1. Who was going to control the group?
2. Who had the ideas?
3. Who was going to do the work?

Sometimes the students readily resolved these questions:

STUDENT: Who's going to draw the picture?
STUDENT: We'll all do one and pick the best one.

Of course, each group had its own problems and solutions. (During group work, I spent much of my time fetching supplies.)

In addition to running an experiment with fourth graders to test the effectiveness of its project, each group prepared a list of interview questions to get some verbal feedback from the fourth-grade participants. (See Figure C3-4 for an example of one group's dittoed interview sheet.) As it turned out, most groups didn't have time to analyze their interviews completely. On the whole, they received positive feedback (e.g., "the maps were clear"), which at least indicated that they had done good jobs. However, in one case (signs on doors), a group made changes based on comments from the fourth graders about the illegibility of signs.

Toward the end of May, I had each group prepare a progress report containing answers to these questions:

1. What is the name of your group?
2. What have you done so far?
3. What do you still have to do?
4. What are you going to do next?
5. How many more sessions before you are done?
6. When will you be done?

(An example of one group's report is given later in Signs on Doors section). We expected each group to implement and test a proposed solution to the problem of getting around. The students decided they would accept whichever idea resulted in the shortest room-finding times in experiments with fourth graders.

Signs on Walls. An earlier class discussion brought out some problems that this group would face:

1. Would students rip off paper signs?
2. Would the signs be painted?
3. Would directions from all four exits intermingle and become confusing?

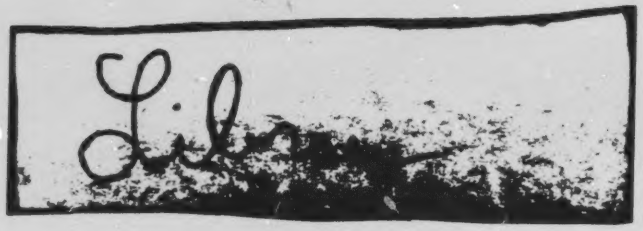


Figure C3-5

The group made signs from construction paper (see Figure C3-5) and chose three rooms (229, gym, library) as destinations and one entrance as a starting point to use in testing three fourth-grade students.* They decided who would do the timimg and who would ask the follow-up interview questions. At the outset of the experiment, the visitors did not notice the wall signs until told by the group, "you can follow the signs." Here are the results:

Student	Time	Place	Recorder
Kari	:32	Rm. 229	Jackie
Tina	1:13	library	Cathy
Susan & Jackie	:05	gym	Annette

A discussion about how the experiment worked went as follows:

---

*The children might discuss the problem of directions from different starting points becoming intermingled. They might decide that there are certain locations for signs, for example, near stairways, where this would not be a problem.--ED.

STUDENT: Kids did not know they were supposed to use the signs on the wall.
TEACHER: Why?
STUDENT: There was nothing to tell them so.
STUDENT: They didn't see them at first.
TEACHER: What can you do to rectify the situation?
STUDENT: Put a note by the door.
STUDENT: Put up a poster: "follow signs."
TEACHER: Do you think it took them less time or more time than the average (from the first testing session?
STUDENT: Less.
TEACHER: If it did take less, what does that prove?
STUDENT: It worked!

We compared their data with the averages from the first testing session:*

(Editor's Note: In the comparisons that follow, several of the groups had incorrect results because of difficulty in subtracting minutes and seconds.)

Student	Time	Place	Average	Evaluation
Kari	:32	Rm. 229	5:37	+5:05 better
Tina	1:13	library	1:49	+ :36 better
Sue & Jackie	:05	gym	4:37	better

Despite their elation at the results, the children suggested that one sample per room was hardly enough to use as proof. They ran another session and recorded these results.

Student	Time	Place	Average	Evaluation
Colleen	1:18	Rm. 229	5:37	+4:19 better
Karen	:54	gym	4:37	+3:83 better
Colleen	1:42	library	1:49	

---

*The children might discuss whether a comparison with the overall average is valid if all three entrances are not used in the second trial. They might decide to find an average time from the first trials for the entrance used in the second trials and use this average for comparison. --ED.

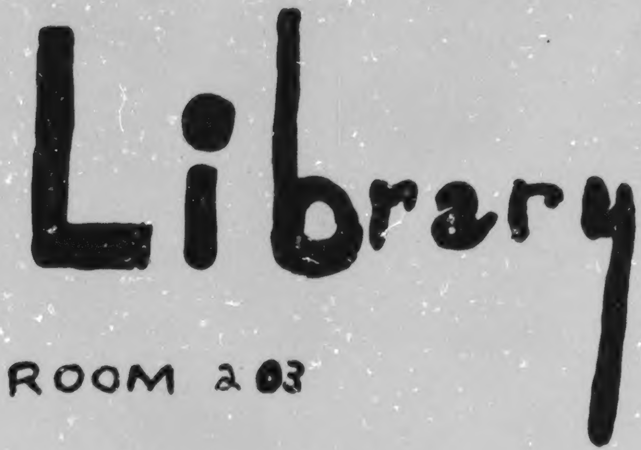


Figure C3-6

(The group didn't consider the library time valid for comparison because the second-floor signs leading to that room had been ripped down.)

Signs on Doors. This group prepared signs, each containing, where appropriate, the teacher's name, the room number, and a distinguishing picture. (See Figure C3-6.) The students chose to ask fourth graders to find the gym, the library, and the counselor's office. As a result of disorganization, two of the visitors tried to find the counselor's office and no one tried to locate the library. Also, some fourth graders, until told otherwise, followed the signs on the walls, even when the signs didn't apply to the room in question. The group recorded the times and compared them to the averages:*

Student	Time	Place	Average	Evaluation
Gary	never found	Counselor	2:18	-2:18 worse
Larry	4:24	Counselor	2:18	-2:08 worse
Pat	3:00	gym	4:37	+1:37 better

A follow-up discussion proceeded in this manner:

TEACHER: How did it go?

STUDENT: It didn't go well because they didn't find it very quickly.

STUDENT: It wasn't good. There weren't enough signs.

STUDENT: We needed larger signs painted in brighter colors.

TEACHER: Is the idea of having signs no good?

STUDENT: No, the idea is OK. It's our signs that were no good.

STUDENT: We shouldn't have a picture on it.

TEACHER: What should you have on it?

STUDENT: Just the room numbers and name.

STUDENT: Not in handwriting, it's too hard to read.

TEACHER: Why did it take twice as long to get to the counselor's office?

STUDENT: They couldn't read the signs, didn't know what floor it was on, didn't know where his office would be.

STUDENT: They didn't know what they were looking for.

STUDENT: They were confused on what they were looking for--Mr. Michaud's office or counselor.

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*See footnote on page 67.--ED.

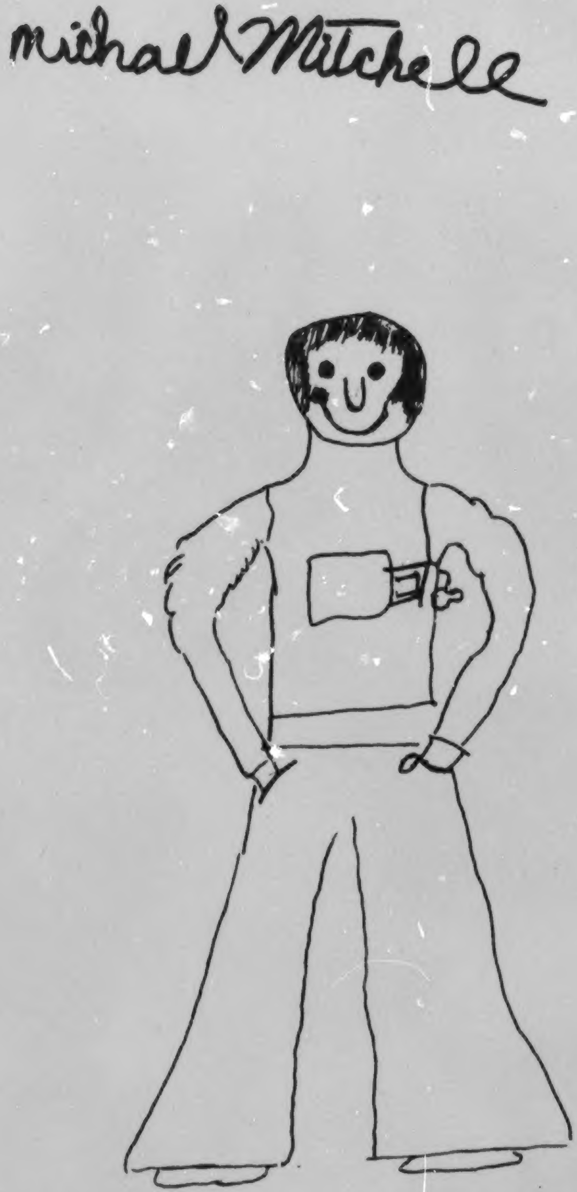


Figure C3-7

(The sign on the door read: "Counselor - Rm. 118," but the students had said, "Find Mr. Michaud's office." The fourth graders didn't know that Mr. Michaud is the counselor.)

The children decided to invalidate their only positive result--the gym--because another student had told the fourth grader which floor to go to. Extremely irritated with the informer, one group member exclaimed, "Anyone knows that makes the data invalid!"

Based on their analysis of the experiment and on their interviews with the fourth graders, students in this group mapped out their future strategy, which they included in the following progress report:

1. Made signs, people tore them down
2. Had fourth graders come - timed - didn't work out
3. Making bigger, clearer signs in bright colors
4. Need three more times - one before students, one with students, one after students

They proceeded as planned, and their second timing session demonstrated a marked improvement as shown below:

Signs on Doors

Student	Time	Place	Average	Evaluation
Todd	1:30	counselor	2:18	+1:28 better
Mike Murphy	:46	library	1:49	+1:03 better
Mike DeBest	:17	gym	4:37	+4:20 better

Traffic Man. "He'd have a dial in his stomach and when you turned the dial, there'd be a window with the directions to the teacher's room," explained the child who conceived the idea.

The traffic man group prepared a construction paper model but had difficulty producing a working model. (Figure C3-7 shows a child's drawing of the intended device.) At first, they wanted to have identical rolls of directions in all their traffic men, until they realized that students coming from different places would need different instructions. They were stuck for a while figuring out the details of building the dial mechanism, but one boy finally built a working model at home (with some help from his father, I suspect). The model generated enthusiasm for continuing.

Because members of this group did not get along well, they split into two groups: one to work on a wooden traf-

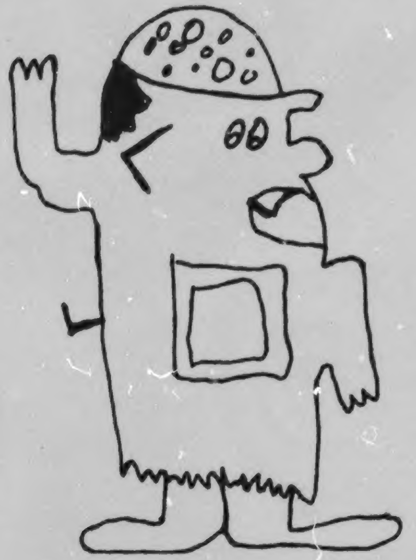


Figure C3-8

fic man; the other to work on a cardboard version. Both groups had initial problems deciding how to insert the dial in the figure's stomach. The cardboard group unsuccessfully tried glue, a brad, and then a long hairpin. Both groups finally tried the same solution: cutting out a center section in the traffic man. Members of the cardboard group still couldn't attach the dial firmly enough. As the end of the year approached, they decided their figure was "too flimsy" and dropped the project.

In contrast, the hole technique solved the attachment difficulties on the wooden model. A small shelf on the lower portion of the square hole supported the direction-giving mechanism (a scroll, rather than a dial). The students had built a wooden crank, which they attached to the upper spool of the scroll, and they firmly wedged the scroll into its compartment. (Figure C3-8 shows a child's sketch of the completed traffic man.) Shortly before the term ended, the group invited six fourth graders and tested the traffic man, but didn't have time to analyze the results (shown below).

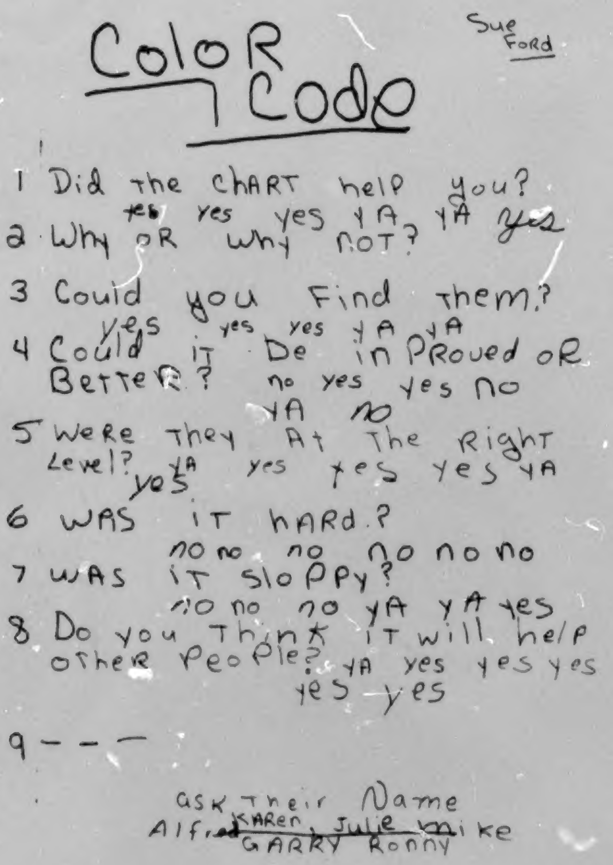
Student	Place	Time	Average	Evaluation
Garry	gym	:13	4:37	+4:24
Mike	"	:12	4:37	+4:25
Ronny	counselor	:25	2:18	+1:53
Garry	library	1:35	1:49	+ :14
Karen	"	:40	1:49	+1:09
Judy	counselor	:13	2:18	+2:05

Color Code. Initial problems facing this group, according to the class, included the following:

1. Would the chart be confusing?
2. There are more than two blue doors.
3. How will you represent the second floor?

Undaunted, the group began making charts, maps, and notes of what they planned to do. They explained that they first had to check all the rooms, the teachers' names, and the room numbers, after which they could select a color for each room and place a color card on the door. They divided the work: one child took the first floor; one the second floor; and one, the third floor and the portables. One discussion I had with the group went like this:

TEACHER: How will it work?



Color Code

Sue Ford

1 Did the chART help you?
yes yes yes YA YA yes
2 Why oR why nOT?

3 Could you Find them?
yes yes yes YA YA
4 Could iT De inPRoved oR BetteR? no yes yes no
YA no
5 Were They At The Right Level? YA yes yes yes YA
yes
6 WAS iT hARd?
no no no no no no
7 WAS iT SloPPy?
no no no YA YA yes
8 Do you Think iT will help other People? YA yes yes yes
yes yes

9 - - -

ask Their Name
Alfred KARen, Julie mike
GARRY Ronny

Figure C3-9

STUDENT: Kids will look at the chart, see the color, name, and room number, and then look for the room.

STUDENT: There will be a section for first floor, second floor, and third floor.

TEACHER: Where's the chart going to be?

STUDENT: On each floor and at each of the four doors.

TEACHER: What are you doing right now?

STUDENT: Me and Dottie are working on a model of the chart for the first floor.

As the group progressed, the chart grew very complicated; the children resorted to stripes after running out of solid colors. They concerned themselves with making sure that each room had a unique card. Although doors in the school are painted (some red, some blue, etc.), any color coordination between a card and its corresponding door was strictly an accident. Despite the burgeoning complexity, the children completed their chart, prepared and placed those cards needed for their timing session, and wound up with the following results:

Name	Place	Time	Average	Evaluation
Julie	library	:42	1:49	+1:07
Ronnie	"	:58	1:49	+ :51
Mike	cafeteria	1:00	2:09	+1:09
Gary	"	:13	2:09	+1:56
Karen	gym	:30	4:37	+4:07
Julie	"	:30	4:37	+4:07

Time didn't allow the children to analyze the data, but they did make a written record of responses to their follow-up interview questions (see Figure C3-9).

Map Rack Group. In an earlier class discussion, students pointed out issues that the map rack group would have to settle:

1. How many maps would be needed?
2. Would students rip off the maps?
3. How to keep maps in the map rack.
4. What to make the rack out of.
5. Would the rack be seen from the door?
6. Would students rip off the rack?

The group began by dividing the responsibilities: two children worked on constructing the map rack and the others

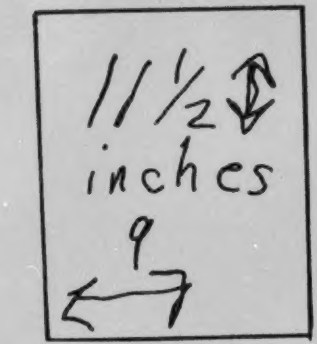


Figure C3-10

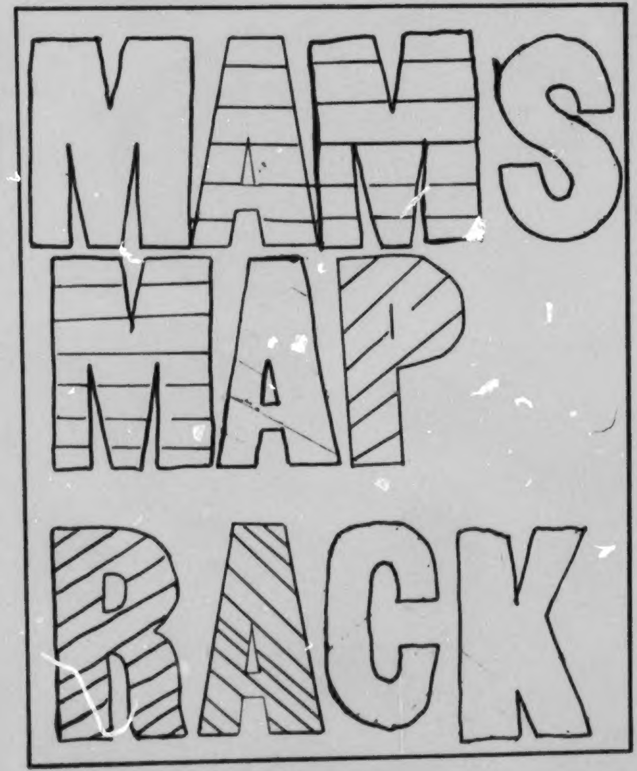


Figure C3-11

worked on preparing maps for duplication. Two boys measured a piece of notebook paper to get dimensions for the map box. When they couldn't agree on the first measurements, they concluded it was incorrect and remeasured. I supplied the rack builders with plywood after they submitted measurements to me (see Figure C3-10).

Out of the five school exits, only the three main ones would have a map rack, the students decided. They also decided not to worry about theft, and to make the rack visible, they would prepare signs (see Figure C3-11) that pointed to it.

For the testing session, they placed a filled map rack near one door and told three fourth-grade students which rooms to find.

In follow-up interviews conducted by the group, the fourth graders said the maps were clear and helpful. A sample copy of one of the maps is shown in Figure C3-12.

As a class we compiled this chart to compare the group's results.

Student	Place	Time	Average	Evaluation
Kirt	gym	1:05	4:37	+3:32 better
Mike DeBest	cafeteria	1:13	2:09	+ :96 better (1:36)
Todd	library	:69	1:49	+ :80 better (1:20)

Minutes after we computed the second evaluation time (Mike D.) on this chart, one boy inquired, "the time and the evaluation time should add up to the average time, shouldn't it?" I said yes and we tried this on the board:

$$\begin{array}{r} 1{:}36 \\ +\ \underline{1{:}13} \\ 2{:}49 \neq 2{:}09 \end{array}$$

"Oh no!" "Something's wrong!" The class was stunned. Finally, one student pointed out that we couldn't subtract seconds from minutes without first converting to the same unit. We recalculated the evaluation time, checked our subtraction, and altered the group's chart accordingly.*

---

*The children in the other groups might check to see if the same type of mistake had been made in their charts.--ED.

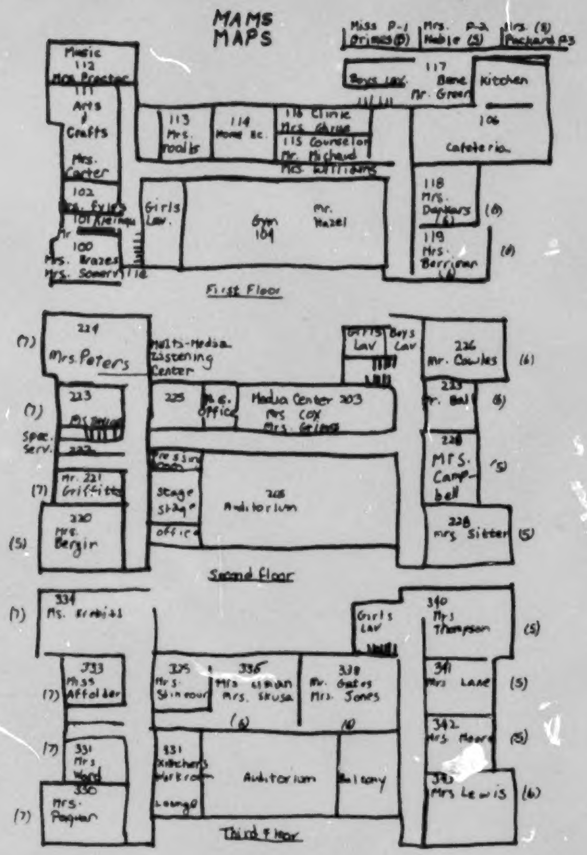

MAMS
MAPS
Miss P-1 Primes (8)
Mrs. P-2 Noble (5)
Mrs. (8) Packard P3
Music
112
Mrs. Proctor
111
Arts & Crafts
Mrs. Carter
102
Mrs. Fyles
101 Kleinau
Mr
100
Mrs. Brazes
Mrs. Somerville
113
Mrs. Woolls
114
Home Ec.
116 Clinic
Mrs. Gline
115 Counselor
Mr. Michaud
Mrs. Williams
117
Bane
Mr. Green
Boys Lav.
Kitchen
106
Cafeteria
Girls Lav.
Gym
104
Mr. Hazel
118
Mrs. Danvers
(8)
119
Mrs. Berriman
(8)
First Floor
224
(7)
Mrs. Peters
Multi-Media Listening Center
Girls Lav
Boys Lav
226
Mr. Cowles
(6)
223
(7)
Spec. Serv.
222
225
Office
Media Center 203
Mrs Cox
Mrs. Grimes
227
Mr. Ball
(6)
Dressing Room
Stage
Mr. 221 Griffiths
(7)
205
Auditorium
office
228
Mrs. Campbell
(5)
220
Mrs. Bergin
(5)
229
Mrs Sitter
(5)
Second floor
334
(7)
Ms. Krebitz
Girls Lav
340
Mrs Thompson
(5)
333
Miss Affolder
(7)
335
Mrs. Skinrour
336
Mrs. Skusa
338
Mr. Gates
Mrs. Jones
(6)
(8)
341
Mrs Lane
(5)
331
Teachers Workroom
Lounge
Auditorium
Balcony
342
Mrs. Moore
(5)
(7)
331
Mrs Ward
330
Mrs. Paquin
(7)
343
Mrs Lewis
(6)
Third Floor

Figure C3-12

Figure C3-13

$$\begin{array}{r} {}^{1}\ {}^{60} \\ \cancel{2}{:}09 \\ -\ \underline{1{:}13} \end{array} = \begin{array}{r} 1{:}69 \\ -\ \underline{1{:}13} \\ {:}56 \end{array} \qquad \begin{array}{r} {:}56 \\ +\ \underline{1{:}13} \\ 1{:}69 \\ +\ 1\ -60 \end{array} = 2{:}09$$

Room Numbers. Several renumbering attempts at the school over the past few years left our room-number system in disarray. The five students comprising this group devised their own coding sequence--starting with a room at one corner of the first floor, they labeled it number one and continued until every room had a number. The children prepared charts of their system to be hung on the walls and made numbers for doors. From construction paper of various colors, they cut out digits and pasted these onto strips of heavy white paper to facilitate placement on doors (see Figure C3-13.) The group members selected three rooms for testing fourth graders, performed the experiment, and compiled a chart comparing their data with the corresponding averages.

Student	Place	Time	Average	Evaluation
Tracy	gym	:24	4:37	+4:13
Tina	"	:03	4:37	+4:34
Tina	office	:05	--	--
Tracy	"	"2.2"	--	--
Mike D.	Rm. 229	3:25	5:37	+2:12
Todd	Rm. 229	never found	5:37	--

The class analyzed this data and decided to throw out the two office times because we had no averages for comparison. (The group was supposed to send fourth graders to the library, not to the office.) Also, a student had recorded one of these times as "2.2" and couldn't remember whether this meant 2:02 or 2:20. The class discovered that the group never placed a number on Room 229 and that explained why one person never found it.

Furthermore, the group mistakenly sent fourth graders to Room 229, instead of to the counselor's office. For these reasons, the class discarded both trials for Room 229. This decision left just the data for the gym, which totaled an impressive evaluation time of +8:47.

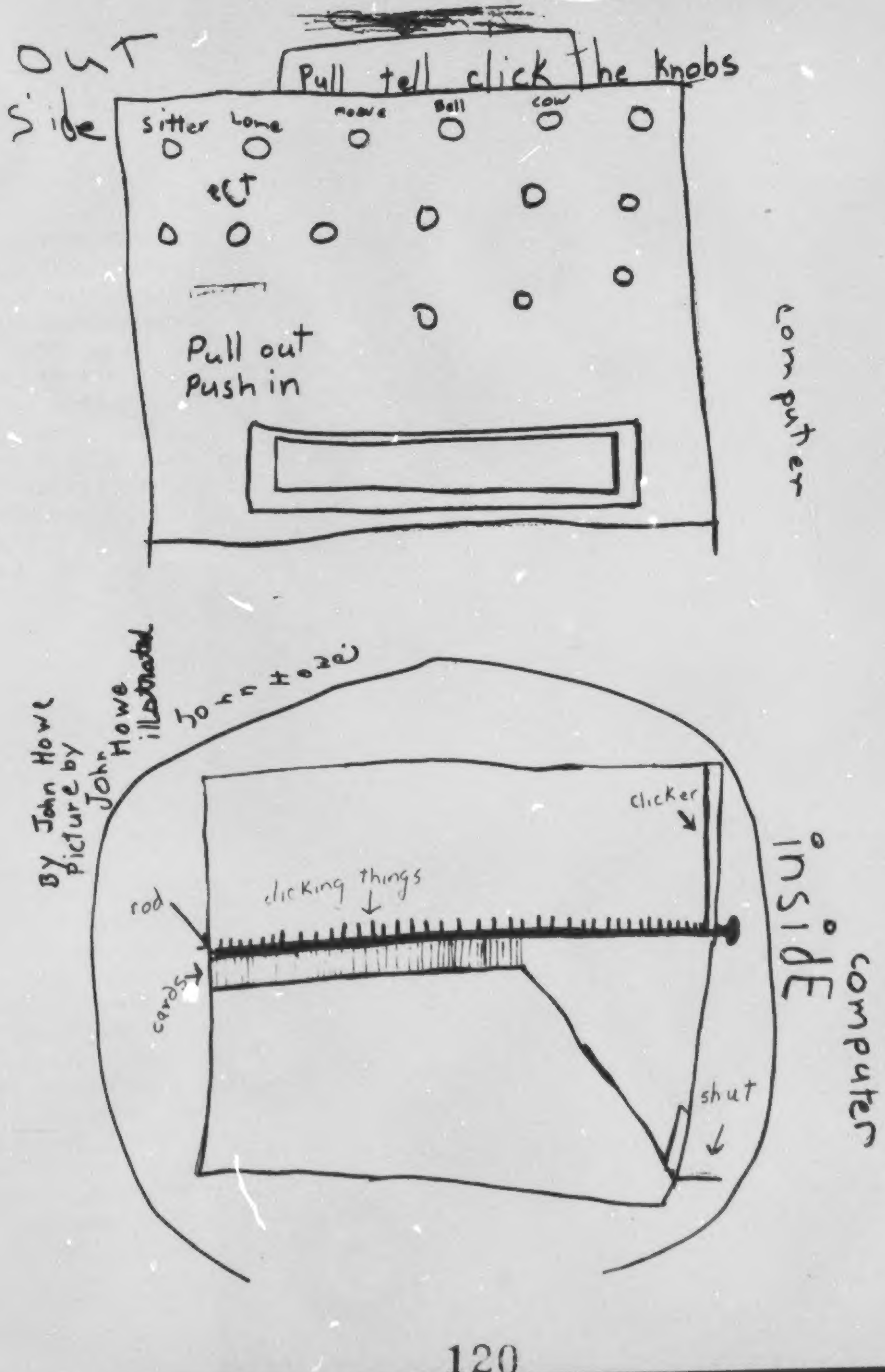

Out side
Pull tell click the knobs
sitter
Lone
moove
Ball
cow
ect
Pull out
Push in
computer
By John Howe
picture by John Howe
illustrated
clicker
clicking things
rod
cards
shut
inside
computer

Figure C3-14

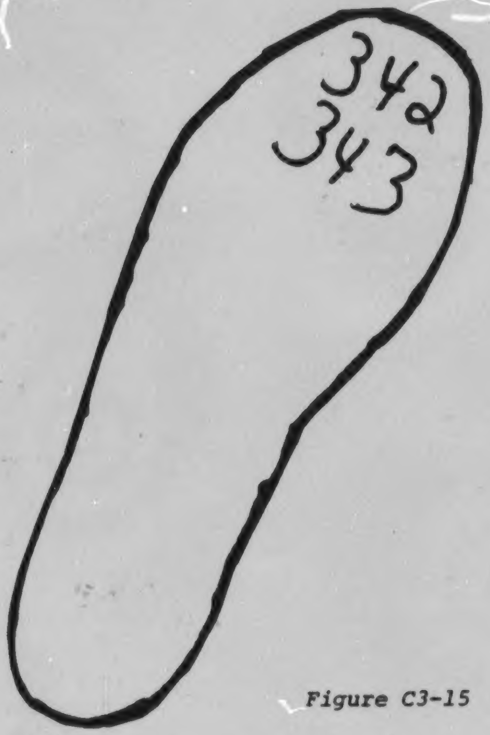


Figure C3-15

Map Rack	+5:08
Signs on Door	+6:11
Color code	+6:23
Traffic Man	+6:31
Signs on Wall	+10:13
feet on Floor	+7:24
no. on Door	+8:47

Figure C3-16

Feet on Floor. Formerly called the computer machine group, these children had unsuccessfully tried to put into practice an idea described by its conceiver as follows:

> A box with a lot of buttons at the front. You'd find the button with the teacher's name you were looking for, pull it out and a card would drop out telling you where to go. The card would be attached to a long pole or stick. When you pulled the stick, it would release the card.

(Figure C3-14 shows this boy's preliminary design for the machine.)

Deciding this idea was not feasible, the group pursued a more easily implemented scheme. From different colored sheets of construction paper, the children cut out footprint-shaped signs and labeled these with room numbers or room names (see Figure C3-15). Footprints leading to a particular room were all one color. The students selected three rooms for their experiment, taped the corresponding signs to the floors along the intended routes, and ran their experiment. They drew up the following chart to compare their results with the appropriate averages:

Student	Place	Time	Average	Evaluation
Al	Rm. 229	:20	5:37	+5:17
Cheryl	Rm. 229	1:34	5:37	+4:03
Mike D.	counselor	1:00	2:18	+1:18
Al	counselor	:30	2:18	+1:48
Todd	library	1:00	1:49	+ :49
Al	library	1:10	1:49	+ :39

Near the end of school in June, all results were in and the class turned to the issue of deciding the best technique for helping students get around our school. Students added the evaluation times for each group and then, as they previously had decided, selected the group with the highest score.* (See Figure C3-16 for a student's copy of the totals.) Signs on walls topped all other groups with an evaluation time total of ten minutes and thirteen seconds.

---

*The children might discuss whether comparing total scores is fair if the different groups had different numbers of trials. Averages for the different groups might be compared instead of total scores.--ED.

Many students felt this method was the best anyway because, during the timing activities of other groups, fourth graders often had a tendency to follow the wall signs.

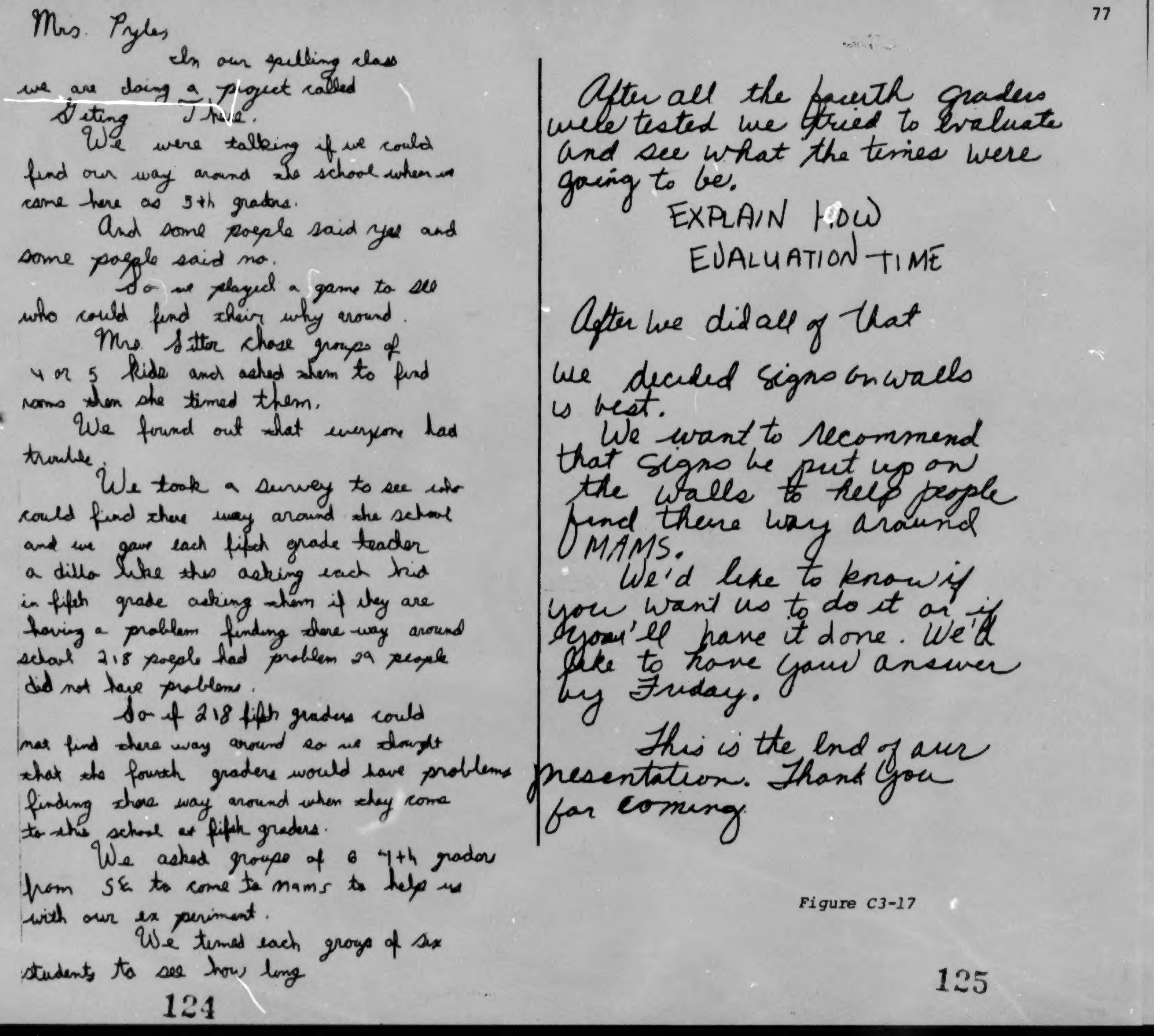
Presenting their recommendation to the principal remained the students' only task before implementing their chosen program. (When we had previously discussed implementation, I had to constantly remind the children that the principal's approval was essential.) After a long discussion, in which I emphasized that our principal knew nothing about what we were doing, the students outlined a comprehensive game plan for our presentation, breaking it down into these three sections:

1. Identified a problem
2. Tried to solve (presentations by each group)
3. Collected and analyzed

We decided who would do what, and then some children wrote and practiced their speeches (see Figure C3-17) and others prepared poster-sized charts. One sample of these is shown in Figure C3-18.

Convinced by their presentation, the principal accepted the students' recommendation. She asked them whether they wished to take the responsibility of putting signs on the walls or whether she could have it done by the office staff. They had already voted to let her make that decision, they told her. She asked them to take charge and they accepted.

Three volunteers stayed behind during our class picnic to make enough directional signs for the entire school. Five other students volunteered to return one day early in September to put up the signs.



Mrs. Pyles

In our spelling class we are doing a project called Geting There.

We were talking if we could find our way around the school when we came here as 5th graders.

And some poeple said yes and some poeple said no.

So we played a game to see who could find their why around.

Mrs. Sitter chose groups of 4 or 5 kids and asked them to find rooms then she timed them.

We found out that everyone had trouble.

We took a survey to see who could find there way around the school and we gave each fifth grade teacher a ditto like this asking each kid in fifth grade asking them if they are having a problem finding there way around school 218 poeple had problem 29 people did not have problems.

So if 218 fifth graders could not find there way around so we thought that the fourth graders would have problems finding there way around when they come to this school as fifth graders.

We asked groups of 6 7th grader from SE to come to mams to help us with our ex periment.

We timed each group of six students to see how long

After all the fourth graders were tested we tried to evaluate and see what the times were going to be.

EXPLAIN HOW

EVALUATION TIME

After we did all of that we decided signs on walls is best.

We want to recommend that signs be put up on the walls to help people find there way around MAMS.

We'd like to know if you want us to do it or if you'll have it done. We'd like to have your answer by Friday.

This is the end of our presentation. Thank You for coming.

Figure C3-17

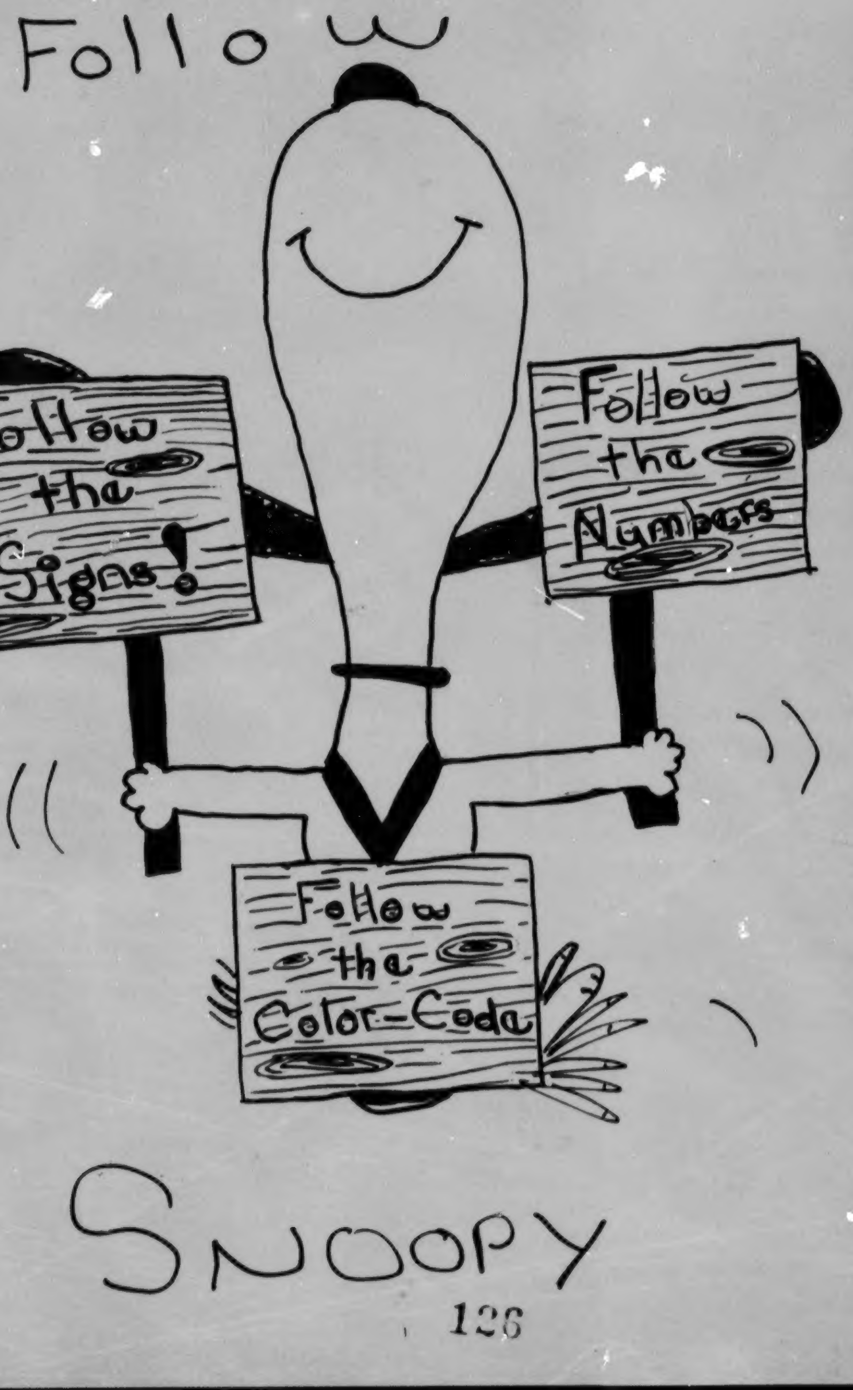

Follow
Follow the Signs!
Follow the Numbers
Follow the Color-Code
SNOOPY

Figure C3-18

4. LOG ON GETTING THERE

by Madeline Davidson*
Stratton School, Grade 6
Arlington, Massachusetts
(September 1974-October 1974)

ABSTRACT

Students in this sixth-grade class worked on the Getting There challenge of finding out how to use public transportation in Boston for field trips. They chose a site for their trip, collected necessary information on schedules, costs, and routes, and formulated plans for the day. Some of the information they gathered was later used to orient other students to the Boston public transportation system.

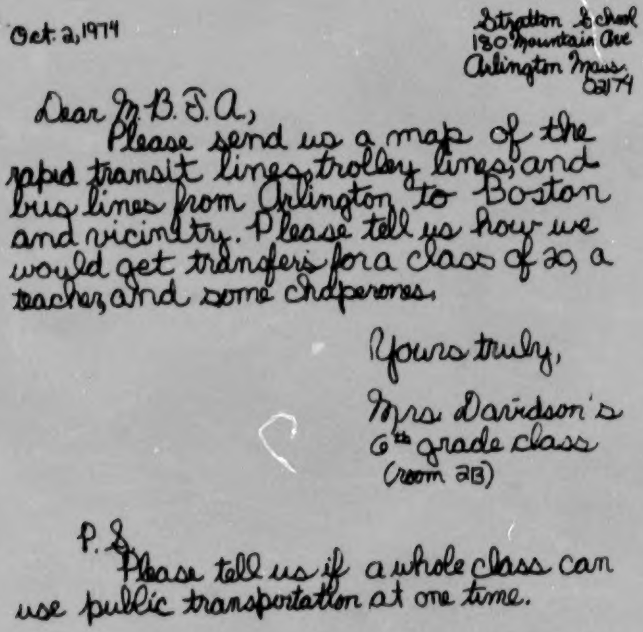
My class was interested in going on special field trips in and around Boston, however, the prohibitive cost of renting buses made it necessary for them to explore different ways to get to the places to which they wanted to go. Initially the children chose the Arnold Arboretum as the site for their first field trip; later, after considerable work had been done to plan their trip, they decided to choose a different place to visit because of unrest in that section of the city and fears that it would not be safe to travel to the Arboretum.

During a class session held later in the week the children decided to visit the Boston Museum of Science. The trip was to be made with another class, but the plans for both classes were developed by my students. The following five groups were formed to collect necessary information and organize the trip:

1. routes
2. cost
3. time
4. schedule and grouping of children with chaperones
5. permission slips

The children in each group met in different parts of the room to begin their investigations.

Members of the group working on routes for the trip used a map of the rapid transit system between Arlington and



Oct. 2, 1974

Stratton School
180 Mountain Ave
Arlington Mass.
02174

Dear M.B.T.A.,

Please send us a map of the rapid transit lines, trolley lines, and bus lines from Arlington to Boston and vicinity. Please tell us how we would get transfers for a class of 20, a teacher, and some chaperones.

Yours truly,

Mrs. Davidson's
6th grade class
(room 2B)

P.S.
Please tell us if a whole class can use public transportation at one time.

Figure C4-1

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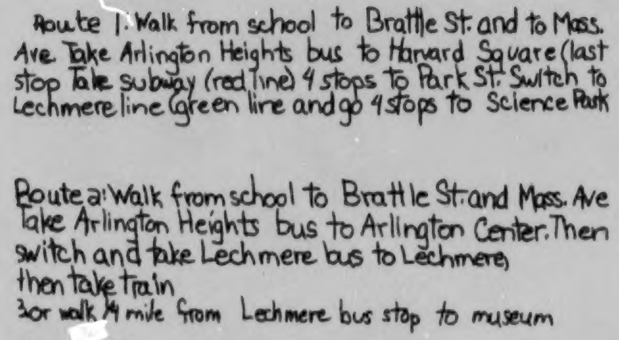
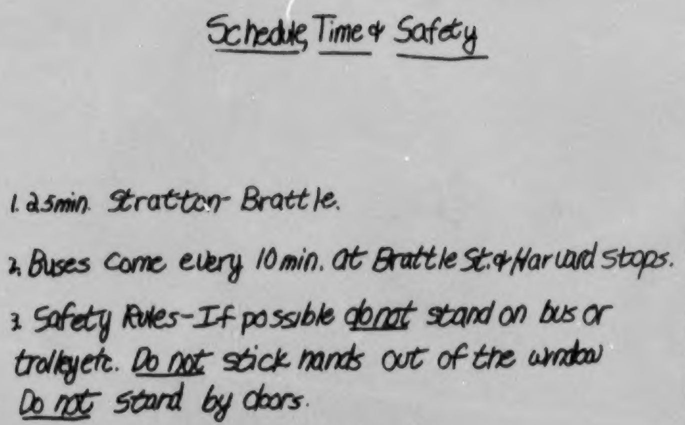
*Edited by USMES staff



Route 1: Walk from school to Brattle St. and to Mass. Ave. Take Arlington Heights bus to Harvard Square (last stop Take subway (red line) 4 stops to Park St. Switch to Lechmere line (green line and go 4 stops to Science Park

Route 2: Walk from school to Brattle St. and Mass. Ave Take Arlington Heights bus to Arlington Center. Then switch and take Lechmere bus to Lechmere,
then take train
3 or walk 1/4 mile from Lechmere bus stop to museum

Figure C4-2



Schedule, Time & Safety

1. 25 min. Stratton-Brattle.

2. Buses come every 10 min. at Brattle St. & Harvard stops.

3. Safety Rules-If possible do not stand on bus or trolley etc. Do not stick hands out of the window
Do not stand by doors.

Figure C4-3

Boston which their classmates had requested from the Massachusetts Bay Transit Authority (MBTA) while planning their original trip to the Arboretum. (The letter they had sent can be seen in Figure C4-1.) From this map they devised the following three routes to get from our school to the Museum of Science:

1. Take a bus from Brattle Street and Massachusetts Avenue to Harvard Square. Then take the red line train four stops to Park Street. Switch at Park Street to the Lechmere train on the green line and go four stops to Science Park.

2. Take a bus from Brattle Street and Massachusetts Avenue to Arlington Center. Switch to the Lechmere Station bus and take it to the last stop, Lechmere Station. Switch to the green line train and go one stop to Science Park.

3. Repeat the route indicated in number 2 until arriving at Lechmere Station. Then walk ¼ mile from bus stop to Museum of Science.

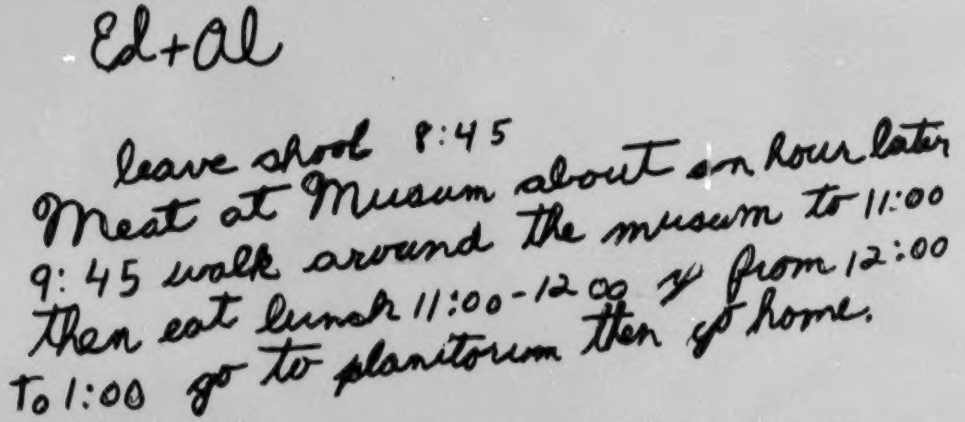
Students decided to prepare copies of the three routes using a duplicating master; a copy of their "routing sheet" can be seen in Figure C4-2.

Those students who worked on the committee setting up traveling groups used the class lists to split the children going on the trip into three groups. The following criteria were used to make group assignments:

1. friends
2. behavior problems
3. an equal number of boys and girls in each group

In addition, members of this committee prepared color-coded name tags for members of each group to wear and duplicated a schedule and safety warning for each student, a copy of which can be seen in Figure C4-3.

Those students who were members of the time and schedule group used the information collected earlier to plan the day. They decided to leave the school at 8:45 A.M., to meet at the museum at 1:00 P.M. to return to school. A copy of the schedule developed by members of this group can be seen in Figure C4-4. The students who had volunteered to determine



Ed+Al

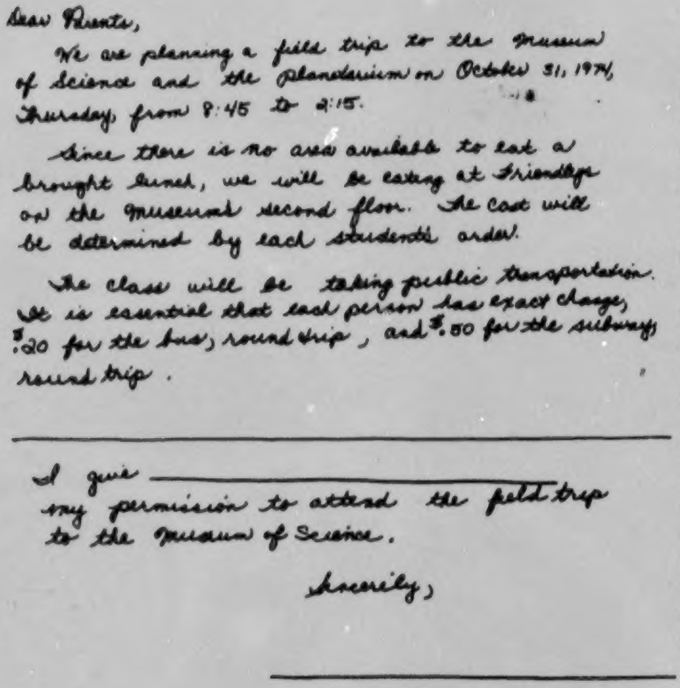
leave shool 8:45
Meat at Musum about an hour later
9:45 walk around the musum to 11:00
then eat lunch 11:00-12:00 & from 12:00
To 1:00 go to planitorium then go home.

Figure C4-4

the cost of the field trip estimated that the cost of lunch would be $1.15 and after the class decided on the route they wanted to take, they determined the cost per child of public transportation to be 70¢.

When the class met to hear reports from each group, there was a great deal of discussion after the children on the "route committee" had given their report. We decided that each class would take a different route to prevent severe congestion on the way to and from the museum. Each child was to receive a copy of the route for convenience and in case of an emergency. My class decided to go through Harvard Square because it would involve fewer buses and less confusion, and it would offer better protection in case of poor weather. A copy of the permission slip that was sent home can be seen in Figure C4-5.

The children agreed after the trip was over that their planning was useful and helped make the trip a success. My class decided to make the information that they had gathered on the public transportation system of Boston available for other classes. They worked to orient others to the public transportation system of Boston for use during field trips. In preparing a pamphlet the students listed important places to visit in the Boston area. The listing included the address of the site, the nearest MBTA stop, and the MBTA line on which the stop could be found (Figure C4-6). An MBTA map, as shown in Figure C4-7, was also included in the pamphlet. In preparing the pamphlet the students found it necessary to scale a larger MBTA map to fit onto smaller ditto paper.



Dear Parents,

We are planning a field trip to the Museum of Science and the Planetarium on October 31, 1974, Thursday, from 8:45 to 2:15.

Since there is no area available to eat a brought lunch, we will be eating at Friendlys on the Museum's second floor. The cost will be determined by each student's order.

The class will be taking public transportation. It is essential that each person has exact change, $.20 for the bus, round trip, and $.50 for the subway, round trip.

I give ______________
my permission to attend the field trip to the Museum of Science.

Sincerely,

____

Figure C4-5

Place	location	Stop	line
American Museum of Negro History	70 Charles St.	Charles MGH	Red
Aquarium	Atlantic Ave	Aquarium	Blue
Arnold Arboretum	Arborway Forest Hills	Arborway-Forest Hills	Green & Blue
Boston City Hall	Government Center	Government Center	Green & Blue
Boston Common	———	Boylston	Green
Boston Massacre Site	State St.	State	orange & blue
Bunker Hill Monument	Bunker Hill	Charlston-Thompson Sq.	orange
Faneuil Hall	Faneuil Hall Square	State	orange & blue
Federal Building	Post Office	State	orange & blue
Gardner Museum	280 The Fenway	Brigham Circle	green
Henry Wodsworth Longfellow House	Cambridge	Harvard	red
John F. Kennedy's Birth place	83 Beals St. Brookline	Coolidge Corner	green
John F. Kennedy's Federal Building	Government Center	Bowdoin	blue
Museum of Fine Arts	475 Huntington Ave.	Bowdoin	blue
Museum of Science	Boston	Science Park	green
New England Museum	290 Huntington Ave	Bowdoin	blue
Old City Hall	School St.	State	orange & blue
Old Granary Burying Ground	Fremont St.	Park	green & red
Old North Church	Salem St.	Haymarket	green & orange
Old South Meeting House	Washington & Milk	State	orange & blue
Peabody & Harvard Museum	Divinity Ave Cambridge	Harvard Sq.	red
Paul Revere House	19 North Square	Haymarket	green & orange
Prudential Center	Boylston St.	Prudential	green
Public Gardens	Boylston & Arl. Sts	Arlington St	green
State House	Beacon St.	Park	green & red
U.S. Frigate Constitution	Charlestown	City Square	orange

Figure C4-6

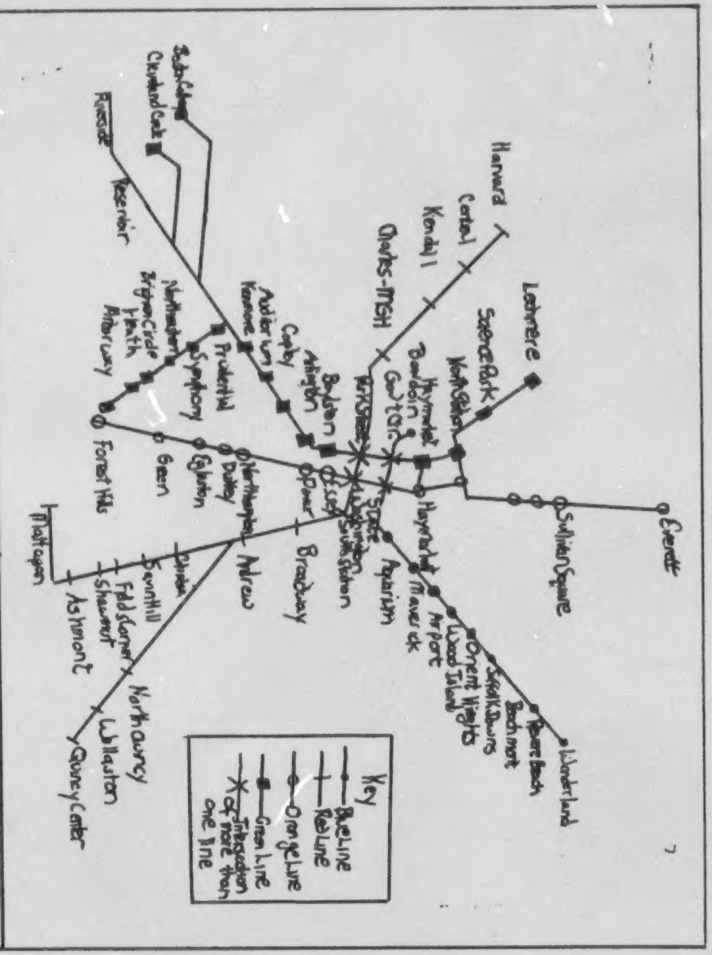

Everett
Sullivan Square
Wonderland
Revere Beach
Beachmont
Suffolk Downs
Orient Heights
Wood Island
Airport
Maverick
Aquarium
Lechmere
Science Park
North Station
Haymarket
Haymarket
Bowdoin
Gov't Ctr.
State
Harvard
Central
Kendall
Charles-MGH
Park Street
Washington
South Station
Boylston
Arlington
Essex
Dover
Broadway
Copley
Auditorium
Kenmore
Prudential
Symphony
Northampton
Dudley
Egleston
Green
Forest Hills
Andrew
Boston College
Cleveland Circle
Riverside
Reservoir
Northeastern
Brigham Circle
Heath
Arborway
Columbia
Savin Hill
Fields Corner
Shawmut
Ashmont
Mattapan
North Quincy
Wollaston
Quincy Center
Key
Blue Line
Red Line
Orange Line
Green Line
Intersection of more than one line

Figure C4-7

5. LOG ON GETTING THERE

by Tom Dumler*
Heatherwood School, Grade 6
Boulder, Colorado
(September 1974-February 1975)

ABSTRACT

This sixth-grade class worked on the challenge two or three hours a week for six months. They felt their most important problems in getting from one place to another were safety getting to school and a means of transportation to get from their neighborhood into town. A bit of work was done on the safety of a crossing near school, but the class's interest soon focused on two solutions for transportation to town, a bike path and a bus route. They surveyed all the classes in school to find out student interest in these proposals, which turned out to be high. They then contacted the local authorities to find out what they should do to have their ideas heard. Since the bus authorities were conducting their own investigation into the possibility of a bus route to the area, the class decided not to work on this. However, the County Commissioner offered to come to talk to the class about the bike trail. He told the class to raise a petition in the area and then make a formal presentation to the commissioners. The class collected signatures for the petition, inquired about rights-of-way, mapped out the best route, and inquired about the cost of the project. When the petition was ready, they made a presentation to the commissioners and explained how they got interested in the bike path, why it was necessary, what the results of their school survey were, where the bike path should go, and how they had collected signatures. The commissioners seemed impressed with their presentation and ordered the County Engineer to conduct a feasibility study of the bike path. The children were very pleased with their success and were optimistic that the bike trail would be approved.

To introduce the challenge to my class at the Heatherwood School in Boulder, Colorado, I asked the class if they had ever experienced any difficulty getting from one place to another. The children told me about problems finding friends' houses, reading maps, getting lost on vacations, detours, and changed landmarks. They also suggested several ways to avoid these problems—asking someone for directions, having someone take you there or draw you a map, and using landmarks--and listed other problems:

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*Edited by USMES staff

1. safety
2. crossing busy streets
3. darkness
4. means of transportation to get to town.

The last problems they listed were more important to the class than the ones we had originally discussed, especially the problem of getting into town. This is important to the children because Heatherwood is a small community some miles out of town with very little in the way of stores or recreational facilities for the children.

At the next session we continued our discussion. The children were interested in two problem areas, safety getting from home to school and a means of transportation to get to town. The problem in getting to school was that many children have to cross a busy, dangerous 50 m.p.h. road (75th Street). If their parents won't let them cross it, they have to take the school bus. We discussed getting a push-button crosswalk light, a school patrol, or a pedestrian bridge. In discussing the problem of getting to town we discovered that many of the children had bicycles that they would like to ride to town. However, the children said that the only two roads to town are narrow and heavily traveled, so that they are too dangerous to use. The class wanted to look into the possibility of having a bike path built on city property even though they realized that this would involve a lot of red tape.*

The other solution they wanted to pursue was a bus route. While the city has buses, there are none in our area yet. There is also a private bus for an apartment complex which comes out nearly as far as Heatherwood. They felt it was worth investigating both the apartment bus and the city buses to try to get a Heatherwood bus started.

The next session was devoted to the problem of crossing 75th Street. The class felt the first thing to do was count the number of children who actually do cross the street. No one could agree on what safety precautions are already there, and so four children were selected to investigate this and report at our next session. Six students volunteered to count children crossing 75th Street before and after school. The class thought it would be a good idea to survey the school to find out how many children would use a crossing if it were safe. They thought we should wait to survey adult opinion in the area until we knew there was student interest in the idea. Other suggestions were to time the cars to see if any obeyed the speed limit at the moment and to take photographs of children trying to cross and cars speeding to show the problem more clearly.

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*For other logs of classes working on bicycle paths, see the Bicycle Transportation Teacher Resource Book.--ED.

At the next session the children reported to the class on the safety precautions already in effect at 75th Street. There were speed limit signs saying 25 m.p.h. during school hours, a crosswalk painted on the road, and the word SCHOOL painted in each lane approaching the crosswalk, but both markings were almost completely worn away. The children noted that cars didn't seem to take any notice of the warning signs, and children didn't bother to use the crosswalk since the cars didn't slow down for it. The children who had volunteered to count people crossing the street had been unable to do this because four inches of snow had fallen and it was too cold.

At this point one boy said he didn't feel that the crossing was a problem that affected enough children, and he would rather work on getting to Boulder. We discussed this and decided to work on three different problems, the 75th Street crossing, the bus route to Boulder, and the bike path to Boulder. The children chose their groups and began to make plans for investigating their problem. However, the whole class soon became involved in taking a survey for the bus route and bike path groups, and the group working on the crossing gradually disbanded.

Both the bus route and the bike path group had decided that the first step was to survey the children in school to see if there were any interest in their proposals. The groups discussed taking surveys and noted the following points:

1. The questions should be able to be answered by yes or no.
2. The questions should be easy to understand.
3. A convenient time should be found to survey each class by asking the teacher.
4. The survey should be relatively short.
5. The persons giving the survey should explain it clearly and should be able to answer questions about it.

The two groups started to plan their surveys. The questions the bus group wanted to ask were--

1. How many of you have a bike?
2. Have you ever ridden your bike to town?
3. Does anyone in your family ride their bike into town?
4. Do your parents let you ride your bike into town?
5. Do you think a bike path to town is needed?
6. Would you ride your bike to town if there was a bike trail?
7. Would your parents let you ride your bike to town if there was a bike trail?
8. Do you think a bus to town is needed?
9. If there was a bus to town would you use it?
10. Would anyone else in your family use it?
11. Would your parents allow you to use the bus?

Figure C5-1

1. Do you think a bus to town is needed?
2. If there was a bus to town would you use it?
3. Would anyone else in your family use it?
4. Would your parents allow you to use the bus?

The questions thought up by four boys in the bicycle path group were--

1. How many of you have a bike?
2. Have you ever ridden your bike to town?
3. Does anyone in your family ride their bike to town?
4. Do your parents let you ride your bike to town?
5. Do you think a bike path to town is needed?
6. Would you ride your bike to town if there was a bike trail?
7. Would your parents let you ride your bike to town if there was a bike trail?

The bike path and bus groups decided to combine their surveys so that the school would be surveyed only once. The survey questions were read to the class and discussed but were not changed. The class decided to keep the two parts of the survey separate rather than mixing the questions. We put the questions in a better order, starting with "Do you have a bike?" This would enable us to tell how many people were not really interested, and we could look at just the answers of those who had bikes. A list of the reordered survey questions is shown in Figure C5-1.

We then talked about how to administer the survey. Since there were twenty-eight children in our class and thirty classes in the school, we decided to work in teams of two, each team visiting two classes. Because there was a paper shortage in school, the class decided to ask the questions aloud and tally the answers by counting hands. The teams copied the questions and drew columns for the yes and no answers. It was suggested that we should also note the total number of children present in each class in case some students didn't vote.

In the next session two girls gave a trial presentation of the survey. They didn't do a very good job, and the class had several suggestions to make. The students' suggestions for this trial presentation and another by two boys follow:

Grade	Total Present	Question #1 Yes	#2 Yes	#3 Yes	#4 Yes
K	61	49	2	28	45
1	95	84	24	28	23
2	115	115	26	60	16
3	89	82	16	35	26
4	79	74	30	48	35
5	111	105	58	69	47
6	107	105	41	68	49
Learning Adjustment	9	8	0	3	6
Class Total	666	612	197	339	247

	Question					
	#5			#6		#7
Grade	Yes	Don't Know	No	Yes	No	Yes
K	10	10	41	35	26	34
1	45	13	37	45	39	42
2	103	0	12	88	27	93
3	71	1	17	64	25	54
4	59	7	13	28	51	67
5	69	0	42	81	30	65
6	82	2	23	78	29	85
Learning Adjustment	6	1	2	8	1	8
Center Total	445	34	187	427	228	448

	Question				
	#8		#9	#10	#11
Grade	Yes	No	Yes	Yes	Yes
K	41	20	35	23	15
1	53	21	43	58	38
2	76	39	70	70	67
3	37	52	45	65	39
4	68	11	63	54	63
5	66	40	76	82	77
6	72	35	84	91	63
Learning Adjustment	5	4	4	5	6
Center Total	418	222	422	418	368

Figure C5-2

1. Remember to count the number of kids in the class.
2. Don't mumble.
3. Talk clearly and loudly enough to be understood.
4. Don't repeat the entire question for both yes and no tally.
5. Both surveyors should count the number of responses to be sure the total is correct.
6. Tell the kids to keep their hands raised until the team has finished counting.
7. When you talk to the floor, you sound like you're mumbling. Hold your head up while speaking.
8. Explain what you are doing before starting.
9. Give a bit more explanation before asking the questions about the bus route.

Three more sessions were spent giving everyone a chance to give a practice presentation. This proved to be necessary as most teams were rather poor, some had copied the questions incorrectly, and one group had even missed a question altogether.

When everyone felt ready to give the survey, the teams went to their allotted teachers to schedule a convenient time. Most of the surveys were given during the next two days, and the two teams I observed did a very competent job.

We started compiling the results of our surveys on the board by listing the answers by grade level. Although there were a few surveys still to be done and some groups had left their results at home, the class decided to find a total for each grade level using what they had and adding the other results later. Two of the teams had rather confused results, and this made some of the students worry about the validity of the total results. However, we managed to reconcile the numbers satisfactorily. It took us three sessions to get the totals completed with much checking and rechecking of the numbers and arithmetic. We also totalled the grade level results to get the totals for the whole school. We then discussed the results of our survey, which are shown in Figure C5-2.

We looked at the answers to each question and considered whether the differences between grade levels were reasonable and what the total result meant for our investigation.* We then voted on whether to continue working on a bike trail. Since 445 out of 666 students had thought a bike trail was needed, the class voted twenty-two to seven to continue working on the bike trail. On a similar vote on the bus route taken at the next session, twenty-three children out of twenty-eight wanted to continue working on the problem and thought there was enough student interest to warrant continuing.

We then divided into two groups to brainstorm the bus problem and the bike path problem. I reminded the children how to brainstorm--to write down all ideas and not shout any ideas down. The bike path group came up with the following things on which we should work:

1. Find out who to talk to in the community in order to get the ball rolling.
2. Decide where the bike path should go--starting point, route, ending point.
3. Money--who will pay for it, how much it will cost. The type of surface will depend on how much money there is to work with.
4. Who is going to build it? Can we help with labor?
5. Publicity--how to get the neighborhood interested, how to let people know about it when it is finished.
6. Regulations--speed, trash baskets along the way, etc.

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*The children might draw graphs that would show the results more clearly. A bar graph could be drawn showing the percentage of "yes" answers to each question. They could also make a triangle diagram that would show by the steepness of the lines how the percentage of "yes" answers to the questions varied. The variation among grade level results could be shown for a particular question by drawing bar graphs or triangle diagrams of the percentage of "yes" answers from each grade. Several of these bar graphs could then be put on one graph by using lines instead of bars. (See "How To" Cards and Background Papers for information on graphing.) --ED.

The bus group brainstormed the following ideas:

1. Who can we talk to?
2. How many buses should there be?
3. Where's the bus going to go?
4. Where should the stops be and how many?
5. What should the hours be?
6. Who's going to drive?
7. What age can ride without a parent?
8. Should different rates be charged for different age groups?
9. How can we get a bus?
10. Are we going to use a school bus?
11. Who is going to provide the money?

During the next few sessions the group working on the bus route decided to call both the Public Service Company, who run the city buses, and the Gunbarrel Apartments who have a private bus. Before making the phone calls, they thought carefully about what to ask and wrote their questions down. The Public Service Company said they were looking into the possibility of running a line out to Heatherwood, but their study wasn't completed yet. The group had had trouble finding who to talk to at the apartment complex, but finally got through to one of the partners who thought our idea was a good one, but their state permit would not allow them to carry anyone but residents, and their insurance would not cover them either. The apartment bus seemed definitely unworkable, and there seemed to be little we could do about the city bus. The children phoned the Public Service Company to offer their help in conducting a neighborhood survey, but they were told to contact them again in January, and so we decided to leave the bus route problem until then.

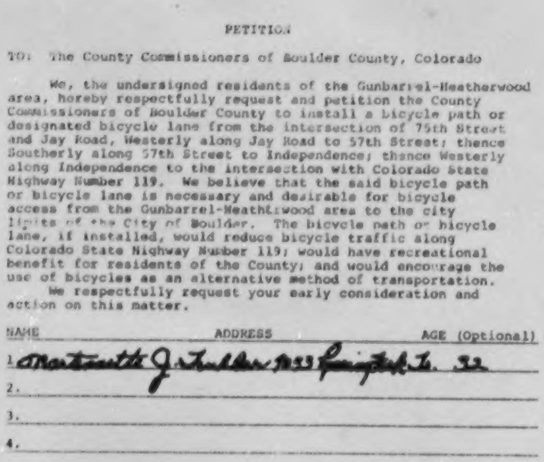
Meanwhile, the bike path group was getting more hopeful results. They started by finding out how much the bike path would cost. After looking at some maps, they decided the path would have to be about five and a half miles long, and after discussion they decided it should be two lanes wide--they thought about four feet was the narrowest possible width. Having already decided that asphalt would be more feasible than concrete, they then called two paving companies to get a rough estimate of the costs. Both estimates were roughly $36,000.

Then they discussed whom to call in the government and realized that they didn't know which government to try, city or county, as there had been a lot of recent activity about the annexation of Heatherwood to the city. The group decided to call both city and county officials to find out what they needed to do to get the bike path considered. When they contacted the County Commissioner's Office, the commissioner for our area volunteered to come to the school to talk to the class. We were all very surprised at this much cooperation, and the children were very excited to be able to arrange a time for the following week.

When the commissioner came to see the class, he showed us the possible routes to town on county roads and pointed out a few other bike paths that had been constructed or were under construction. He pointed out that the county sees a need for bike paths and thinks they are important. The children then asked the commissioner questions, and he was honest with them about the problems involved but was still encouraging. He told us that if we were really serious about continuing with this project we needed to do three things:

1. Call a County Engineer to check on the right-of-way possibilities of different routes.
2. Find out how to write a petition and get as many registered voters as possible to sign. (He pointed out that the more signatures we got, the more it would influence the commissioners.)
3. If we wanted to try to raise some of the four to five thousand dollars it would cost, it would show good faith and also influence the commissioners.

After the commissioner left, we discussed what he had said. The children were still very enthusiastic and wanted to do the things he had suggested. Consequently, two boys went to call the County Engineer, and others started trying to find out how to write a petition. At the next session the boys who called the County Engineer reported that the county had enough right-of-way to construct a bike path along any of the routes they had asked about. We therefore started planning what route our bike path should take. One route was rejected as too long and therefore too expensive. Another route had a very narrow bridge which would be dangerous to use and a separate bridge for bicycles would cost too much to build. The route finally chosen was from 75th Street west along Jay Road to 57th Street, south on 57th Street to Independence Avenue, then west to the Longmont Diagonal to town. According to the map, this wasn't



PETITION

TO: The County Commissioners of Boulder County, Colorado

We, the undersigned residents of the Gunbarrel-Heatherwood area, hereby respectfully request and petition the County Commissioners of Boulder County to install a bicycle path or designated bicycle lane from the intersection of 75th Street and Jay Road, Westerly along Jay Road to 57th Street; thence Southerly along 57th Street to Independence; thence Westerly along Independence to the intersection with Colorado State Highway Number 119. We believe that the said bicycle path or bicycle lane is necessary and desirable for bicycle access from the Gunbarrel-Heatherwood area to the city limits of the City of Boulder. The bicycle path or bicycle lane, if installed, would reduce bicycle traffic along Colorado State Highway Number 119; would have recreational benefit for residents of the County; and would encourage the use of bicycles as an alternative method of transportation.

We respectfully request your early consideration and action on this matter.

NAME	ADDRESS	AGE (Optional)
1. [illegible]	[illegible]	32
2.		
3.		
4.		

Figure C5-3

the shortest route, but was fairly short and not too dangerous.*

One girl in the class said that her father, who is a lawyer, would be glad to write the petition in a legal manner, and she would bring it in when he had finished it. The next thing we discussed was how to take the petition around the entire area without missing some houses or going to some twice. Several children offered to bring in maps so that we could divide the area suitably. Most of the maps turned out to be too small, but one was very detailed, and we used this to divide the entire Heatherwood area among the students in the class. The students worked in groups of two or three to collect signatures from people who lived close to them.

The girl whose father is a lawyer brought in not only the wording of the petition but also a typed original and twenty copies that were ready to be handed out to the teams. A copy of the petition can be seen in Figure C5-3. The children were very enthusiastic and wanted to start canvassing their areas that weekend. They came in on Monday full of tales of their experiences, from people who wouldn't even listen to others who invited them in for cookies. Most of the children seemed to have found a lot of support in the neighborhood. Some had filled their petition sheets with names and needed more sheets, and others had finished their area and wanted to help other teams. A few teams hadn't started canvassing yet.

The teams continued collecting signatures after school during the week. As more children finished their sheets, we discussed what to do for extra space. The lawyer's daughter said that the paragraph at the top had to be attached to the sheet of signatures so people know what they're signing, and so we decided to start using the back of the sheets. We had also made up some student survey forms, and the class decided to take a student form along in case the people they were canvassing had a child who would like to sign. Someone suggested collecting signatures at school, but we decided to try to get signatures from the 10-15 year old age bracket because they would be the ones most likely to use the bike trail. (Older children would borrow their parents' car rather than bicycling.)

After the next weekend the class was very disappointed when it turned out that five children had still not started canvassing their area. They felt that the people who had been working hard shouldn't be held up waiting for those who were "goofing off." The guilty students promised to get started that week.

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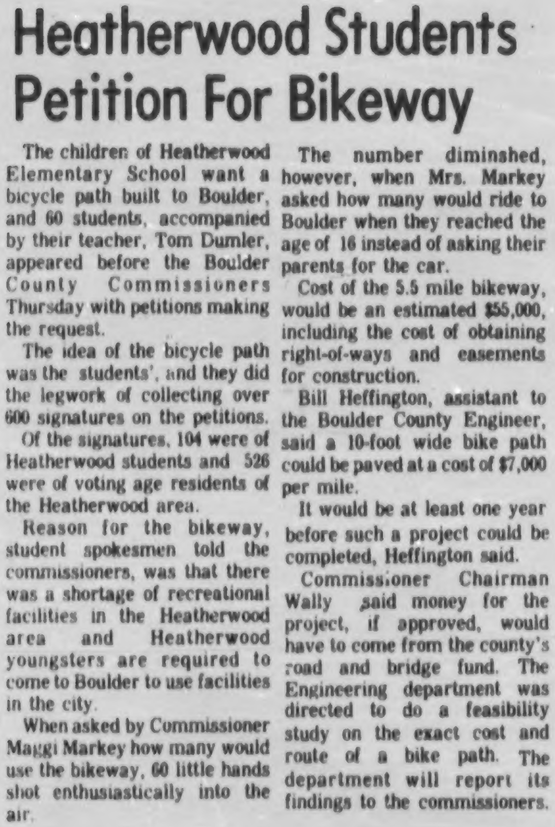
*The class might decide to check the distance along the suggested routes by asking their parents to drive them along the routes. They might also discover other problems of which they were not aware.--ED.

One boy volunteered to call the County Commissioners' Office to find out when we could present our petitions. He reported that the commissioners don't hold evening meetings. The commissioner who had visited the class said he could set up an appointment for us and told us to call when we had finished collecting signatures for our petition.

Before Thanksgiving we totalled our signatures to date--about half the teams were finished or nearly finished. We estimated we had over 500 adult signatures and almost 200 children's signatures; this inspired even the lazy ones to get out over Thanksgiving to collect more. We set ourselves a goal of getting 1,000 signatures before the Christmas vacation so that we could hand them over to the commissioners and get something decided before the first of the year. After Thanksgiving we decided that we should be finished collecting signatures by December 11 and be ready to present the petition to the commissioners by December 19. However, the Commissioners' Office advised us to make a formal presentation to the full committee and scheduled us on the agenda of the January 16 meeting. The children decided it was worth waiting since he said he would make sure that there would be press coverage, which really excited the children.

Meanwhile, we had time to collect more signatures and organize our presentation. There was a lot of discussion as to who should go to the meeting, just a few children or everyone. We decided that everyone who wanted to go should be allowed to attend. Deciding who should give the actual presentation was more difficult. While some thought everyone should give it because everyone had helped, others favored a small group because it would then be less confusing and better organized. They decided to use a small group only, but the questions of how many should be in the group and who they should be were not decided until the next session. The class then decided that from one to four people should be selected to give the presentation, and several methods of making the selection were suggested:

1. those who collected the most signatures
2. someone from each area
3. those who volunteered
4. have an election
5. those who worked hardest.



Heatherwood Students Petition For Bikeway

The children of Heatherwood Elementary School want a bicycle path built to Boulder, and 60 students, accompanied by their teacher, Tom Dumler, appeared before the Boulder County Commissioners Thursday with petitions making the request.

The idea of the bicycle path was the students', and they did the legwork of collecting over 600 signatures on the petitions.

Of the signatures, 104 were of Heatherwood students and 526 were of voting age residents of the Heatherwood area.

Reason for the bikeway, student spokesmen told the commissioners, was that there was a shortage of recreational facilities in the Heatherwood area and Heatherwood youngsters are required to come to Boulder to use facilities in the city.

When asked by Commissioner Maggi Markey how many would use the bikeway, 60 little hands shot enthusiastically into the air.

The number diminshed, however, when Mrs. Markey asked how many would ride to Boulder when they reached the age of 16 instead of asking their parents for the car.

Cost of the 5.5 mile bikeway, would be an estimated $55,000, including the cost of obtaining right-of-ways and easements for construction.

Bill Heffington, assistant to the Boulder County Engineer, said a 10-foot wide bike path could be paved at a cost of $7,000 per mile.

It would be at least one year before such a project could be completed, Heffington said.

Commissioner Chairman Wally said money for the project, if approved, would have to come from the county's road and bridge fund. The Engineering department was directed to do a feasibility study on the exact cost and route of a bike path. The department will report its findings to the commissioners.

Figure C5-4

It was decided to combine #3 and #4. Eight people volunteered and four of these were elected to be in the group making the presentation. The class left it to the group to divide the responsibility among themselves, but they did have some ideas on what the four should include:

1. Some explanation about our area and why we feel a bike path is needed. This should include the information gathered in our school survey.
2. An explanation of where the bike path should be and why we decided on that route.
3. An explanation about our petition and how we collected the signatures.

The presentation group discussed what they should do and after the Christmas vacation gave a practice presentation to our class and another class which had volunteered to be our audience. One of the students spoke about how we got interested in a bike path, and another told why we needed to get to town. The third student presented the results of our school survey, and the fourth described the route we had chosen and explained the petition. The children were very nervous and gave a rather ragged presentation. They really appreciated the other students' comments on what to add and how to improve the presentation. After our discussion the other class said they wanted to go with us to the commissioners' meeting; so our numbers were up to about 60. It took quite a bit of organizing to get cars for everyone. (There were no funds available for buses.)

At the County Courthouse the children were awestruck by the building. The presentation went very well, and the commissioners said it was better than many given by adults. They asked the children many questions, which the children answered well. While we were there, the commissioners decided to conduct a feasibility study on the proposed route and told the children to call the County Engineer in a month to check on progress. An article on our presentation appeared in the local paper (*Daily Camera*, Boulder Colorado, January 17, 1975); this is shown in Figure C5-4.

We discussed the commissioners' meeting at our next class session. The children throught the whole thing had gone very well and were very optimistic. They were pleased that a decision had been made immediately and felt they had definitely achieved something. I was surprised when they then asked about starting on the bus route problem. Their enthusiasm for the bike route had carried over and they wanted to start working on the bus route again. They thought that we ought to decide what to say before calling again about the bus service and broke into small groups to discuss what information we needed before placing our calls. The things they thought we should know before we called were--

1. Where the bus should go in town
2. Tell something about our area
3. Convenient places to stop in Heatherwood to pick up passengers
4. When and how often the bus should run
5. Who would actually be in charge of calling the R.T.D. (Regional Transit District).

During the next two sessions the children worked in small groups on these topics. The scheduling group decided they needed a Boulder bus schedule so that they could have the Heatherwood bus arriving in town at convenient times for transfers to and from other buses. When they had obtained the bus schedule, they decided that there should be half an hour between two buses running during the following hours:

Start		Stop
7:00 A.M.	Mon. thru Thurs.	9:00 P.M.
7:00 A.M.	Friday	10:00 P.M.
7:00 A.M.	Saturday	10:30 P.M.
7:00 A.M.	Sunday	8:00 P.M.

The group working on the bus route in town decided that the bus should make a loop to two locations that meet other Boulder bus routes. One of these was a shopping center and the other a discount store on the main shopping street. They drew a map of the route.

The group working on where the bus should stop in the Heatherwood area had more trouble making any decisions because everyone wanted the bus to stop near their home even if it wasn't a logical place. After working with a map and considering the schedule, they decided on sixteen stops. They thought that if each stop took a minute, the bus would be able to make the round trip in an hour. They planned the stops so that the bus would not leave the main streets and no one would have to walk more than three blocks to catch the bus.*

The group working on telling the Regional Transit District something about our area decided they should find out how many people live in the area that the bus would serve, who would ride the bus, how far we are from town, and what facilities there are in town that we lack out here. Their list of facilities in the area included (1) the school playground, (2) the Boulder reservoir which was three miles away and only useful in the summer, and (3) the country club. The latter is very expensive, and most students' families cannot afford to join. Their list of facilities that our area lacked included banks, stores other than grocery and liquor stores, recreational facilities, and swimming pools.

The group of callers listed the things they needed to find out from the other groups and what else they would need to tell the Regional Transit District. They found out the numbers to call and the name of the person to talk to. When the other groups presented their findings, the callers wrote down the information and then made their phone call. They were told that the Regional Transit District had just started a neighborhood survey in our area the day before. The official said he was glad we were interested and suggested we check later for a progress report. The children took this very well but felt there was nothing further for us to do. As both our ideas for Getting There were being taken up by the appropriate authorities, our unit was at an end, and the children began to get interested in providing after-school recreational activities in Heatherwood--an alternative to providing transportation to facilities in town.

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*The children might get information on the population density in the various areas of the town and then recheck both the route and the stops they had planned.--ED.

D. References

1. LISTS OF "HOW TO" SERIES

The *USMES "How To" Series* are written resources that help children learn skills they need to solve real problems (e.g., designing an opinion survey, drawing various types of graph).

"HOW TO" CARDS

Below are listed the current "How To" Card titles that students working on the Getting There challenge may find useful. A complete listing of both the "How To" Cards and the Design Lab "How To" Cards is contained in the USMES Guide. In addition, the Design Lab Manual contains the list of Design Lab "How To" Cards.

GEOMETRY

G 3 How to Construct a Circle Which is a Certain Distance Around

GRAPHING

GR 1--How to Make a Bar Graph Picture of Your Data
GR 2 How to Show the Differences in Many Measurements or Counts of the Same Thing by Making a Histogram
GR 3 How to Make a Line Graph Pciture of Your Data
GR 4 How to Decide Whether to Make a Bar Graph Picture or a Line Graph Picture of Your Data
GR 5 How to Find Out If There is Any Relationship Between Two Things by Making a Scatter Graph
GR 7 How to Show Several Sets of Data on One Graph

MEASUREMENT

M 1 How to Use a Stopwatch
M 2 How to Measure Distances
M 3 How to Measure Large Distances by Using a Trundle Wheel
M 9 How to Make a Conversion Graph to Use in Changing Measurements from One Unit to Another Unit
M 10 How to Use a Conversion Graph to Change *Any* Measurement in One Unit to Another Unit

PROBABILITY AND STATISTICS

PS 2 How to Record Data by Tallying
PS 3 How to Describe Your Set of Data by Finding the Average
PS 4 How to Describe Your Set of Data by Using the Middle Piece (Median)
PS 5 How to Find the Median of a Set of Data from a Histogram

RATIOS, PROPORTIONS, AND SCALING

R 1 How to Compare Fractions or Ratios by Making a Triangle Diagram*
R 2 How to Make a Drawing to Scale
R 3 How to Make Scale Drawings Bigger or Smaller

BEGINNING "HOW TO" SERIES

The cartoon-style format of this series helps younger children and those with reading difficulties acquire the skills and knowledge they need during work on Getting There.

COLLECTING DATA

"How To" Record Data
"How To" Do an Experiment
"How To" Make an Opinion Survey
"How To" Choose a Sample

GRAPHING

"How To" Choose Which Graph to Make
"How To" Make A Bar Graph
"How To" Make a Bar Graph Histogram
"How To" Make a Conversion Graph
"How To" Make a Line Chart
"How To" Make a Line Graph
"How To" Make a Scatter Graph
"How To" Make a Slope Diagram

MEASURING

"How To" Use a Stopwatch
"How To" Choose the Right Tool to Measure Distance
"How To" Use a Trundle Wheel
"How To" Make a Scale Drawing
"How To" Find the Speed of Things

SIMPLIFYING DATA

"How To" Round Off Data
"How To" Find the Median
"How To" Find the Average

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*Now called slope diagram.

INTERMEDIATE "HOW TO" SERIES

This booklet-style series covers in more detail essentially the same information as the *Beginning "How To" Series* with a few booklets on additional skills. This series requires a greater reading skill and gives students a chance to read something they have a need to read. Those pertinent to Getting There are listed below.

"How To" Collect Good Data
"How To" Round Off Data as You Measure
"How To" Record Data
"How To" Do an Experiment
"How To" Make an Opinion Survey
"How To" Choose a Sample

"How To" Choose Which Graph to Make
"How To" Make a Bar Graph
"How To" Make a Histogram
"How To" Make a Line Graph
"How To" Make a Conversion Graph
"How To" Use Graphs to Compare Two Sets of Data

"How To" Use a Stopwatch
"How To" Choose the Right Tool to Measure Distance
"How To" Use a Trundle Wheel
"How To" Make a Scale Drawing
"How To" Find the Speed of Things

"How To" Tell What Your Data Show
"How To" Find the Median
"How To" Find the Mean
"How To" Find the Mode
"How To" Find Different Kinds of Ranges
"How To" Use Key Numbers to Compare Two Sets of Data

2. LIST OF BACKGROUND PAPERS

As students work on USMES challenges, teachers may need background information that is not readily accessible elsewhere. The Background Papers fulfill this need and often include descriptions of activities and investigations that students might carry out.

Below are listed titles of current Background Papers that teachers may find pertinent to Getting There. The papers are grouped in the categories shown, but in some cases the categories overlap. For example, some papers about graphing also deal with probability and statistics.

The Background Papers are being revised, reorganized, and rewritten. As a result, many of the titles will change.

GRAPHING

- *GR 3 Using Graphs to Understand Data* by Earle Lomon
- *GR 4 Representing Several Sets of Data on One Graph* by Betty Beck
- *GR 6 Using Scatter Graphs to Spot Trends* by Earle Lomon
- *GR 7 Data Gathering and Generating Graphs at the Same Time (or Stack 'Em and Graph 'Em at One Fell Swoop!)* by Edward Liddle

GROUP DYNAMICS

- *GD 2 A Voting Procedure Comparison That May Arise in USMES Activities* by Earle Lomon

MEASUREMENT

- *M 3 Determining the Best Instrument to Use for a Certain Measurement* by USMES Staff

PROBABILITY AND STATISTICS

- *PS 1 Collecting Data in Sets or Samples* by USMES Staff
- *PS 4 Design of Surveys and Samples* by Susan J. Devlin and Anne E. Freeney
- *PS 5 Examining One and Two Sets of Data Part I: A General Strategy and One-Sample Methods* by Lorraine Denby and James Landwehr
- *PS 6 Examining One and Two Sets of Data Part II: A Graphical Method for Comparing Two Samples* by Lorraine Denby and James Landwehr

RATIOS, PROPORTIONS, AND SCALING

- *R 1 Graphic Comparison of Fractions* by Merrill Goldberg
- *R 2 Geometric Comparison of Ratios* by Earle Lomon
- *R 3 Making and Using a Scale Drawing* by Earle Lomon

3. BIBLIOGRAPHY OF NON-USMES MATERIALS

The following books are general references that may be of some use during work on Getting There. The teacher is advised to check directly with the publisher regarding current prices. A list of references on general mathematics and science topics can be found in the *USMES Guide*.

Elementary Science Study (ESS). *Making Maps*. McGraw-Hill Book Co., Webster Division, Princeton Road, Hightstown, N.J.

This booklet for students explains the process and principles of making maps of both indoor and outdoor areas.

_____. *Mapping*. (Teacher's Guide, $5.22)

This is a useful book for teachers which describes much about mapping, including making things to scale and mapping outdoor areas.

For maps of transit systems students may get in touch with local transit authorities. City or town halls may also provide access to maps of local areas.

4. GLOSSARY

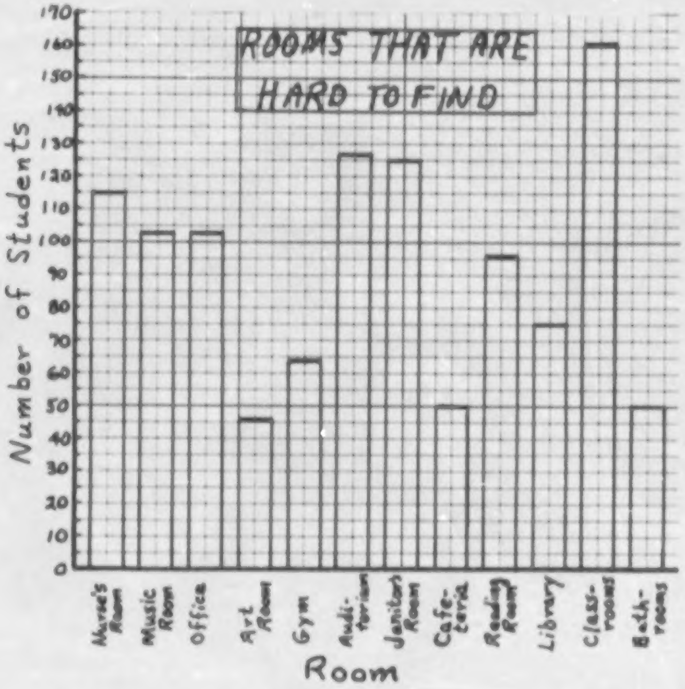
The following definitions may be helpful to a teacher whose class is investigating a Getting There challenge. These terms may be used when they are appropriate for the children's work. For example, a teacher may tell the children that when they conduct surveys, they are collecting *data*. It is not necessary for the teacher or students to learn the definitions nor to use all of these terms while working on their challenge. Rather, the children will begin to use the words and understand the meanings as they become involved in their investigations.

Average	The numerical value obtained by dividing the sum of the elements of a set of data by the number of elements in that set. Also called the mean.
Conversion	A change from one form to another. Generally associated in mathematics and science with the change from one unit of measure to another or the change from one form of energy to another.
Correlation	A relationship between two sets of data.
Cost	The amount of money needed to produce or to purchase goods or services.
Data	Any facts, quantitative information, or statistics.
Distribution	The spread of data over the range of possible results.
Event	A happening; an occurrence; something that takes place. Example: a student finding her way from the classroom to the library.
Frequency	The number of times a certain event occurs in a given unit of time or in a given total number of events.
Graph	A drawing or a picture of one or several sets of data.

Bar Graph

A graph of a set of measures or counts whose sizes are represented by the vertical (or horizontal) lengths of bars of equal widths. Example: survey results on the number of students who have trouble finding various places in the school.

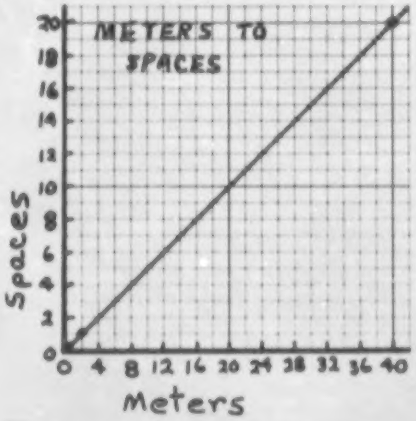
Room	Number of Students
Nurse's Room	115
Music Room	103
Office	103
Art Room	46
Gym	64
Auditorium	127
Janitor's Room	125
Cafeteria	50
Reading Room	96
Library	75
Classrooms	161
Bathrooms	50



Conversion Graph

A line graph that is used to change one unit of measurement to another. Example: changing meters to spaces on graph paper for a scale map.

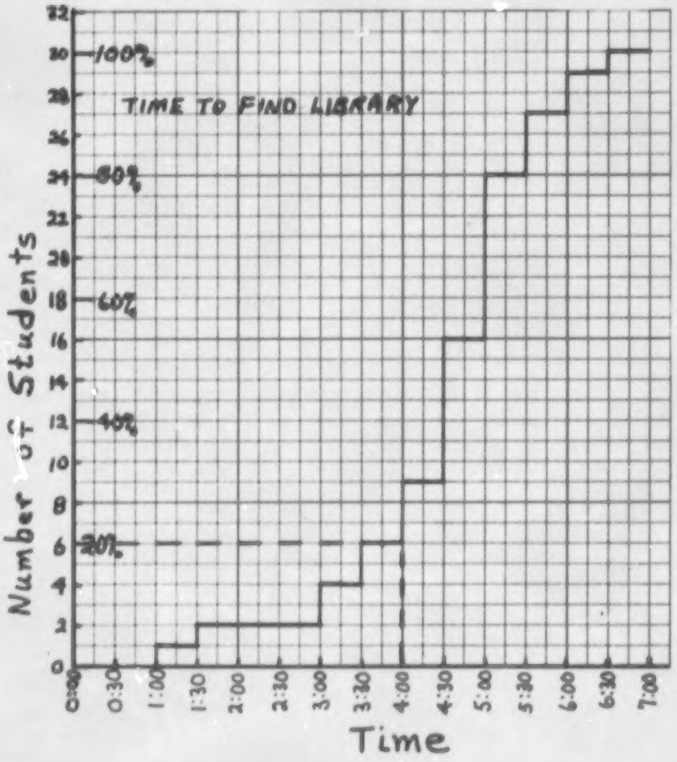
METERS	SPACES
0	0
2	1
40	20



Cumulative Distribution Graph

A graph that can be constructed from a histogram by computing running totals from the histogram data. The first running total is the first value in the histogram data (see table of values). The second running total is the sum of the first and second values of the histogram, the third is the sum of first, second, and third values, and so on. The horizontal scale on the graph is similar to that of the histogram; the vertical scale goes from 0 to the total number of events observed or samples taken (in the example, the total number of students timed). Each vertical distance on the graph shows the running total of the number of samples taken that are less than or equal to the value shown on the horizontal scale; thus, the graph below indicates that six students (or 20% of the total) took four or fewer minutes to go from the classroom to the library.

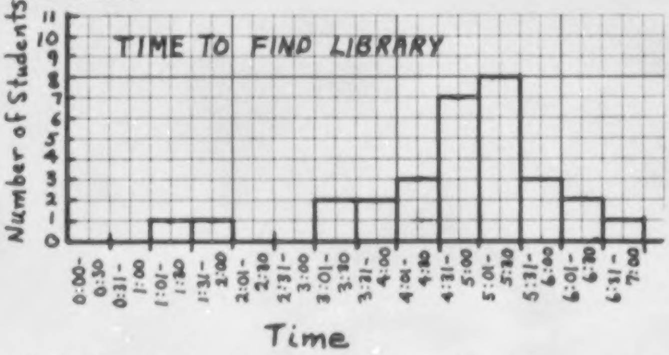
TIME TO FIND LIBRARY (min.:sec.)	TOTAL NUMBER OF STUDENTS
0:30 or less	0
1:00 " "	0
1:30 " "	1
2:00 " "	2
2:30 " "	2
3:00 " "	2
3:30 " "	4
4:00 " "	6
4:30 " "	9
5:00 " "	16
5:30 " "	24
6:00 " "	27
6:30 " "	29
7:00 " "	30



Histogram

A type of bar graph that shows the distribution of the number of times that different measures or counts of the same event have occurred. A histogram always shows ordered numerical data on the horizontal axis. Example: the number of students who go from their classroom to the library in a given period of time.

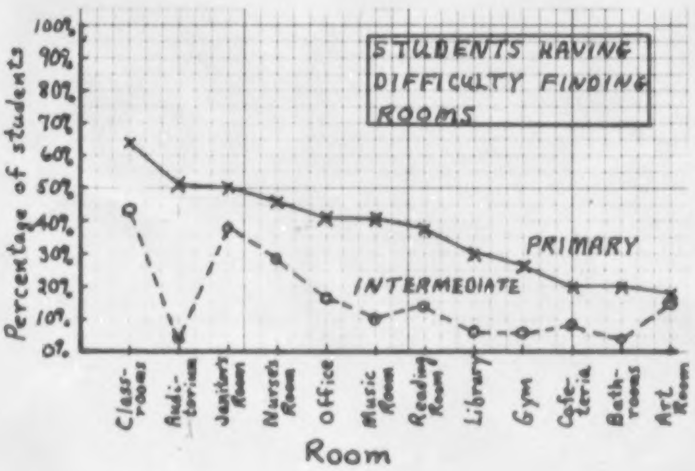
TIME TO FIND LIBRARY (min.:sec.)	NUMBER OF STUDENTS
0:00 – 0:30	0
0:31 – 1:00	0
1:01 – 1:30	1
1:31 – 2:00	1
2:01 – 2:30	0
2:31 – 3:00	0
3:01 – 3:30	2
3:31 – 4:00	2
4:01 – 4:30	3
4:31 – 5:00	7
5:01 – 5:30	8
5:31 – 6:00	3
6:01 – 6:30	2
6:31 – 7:00	1



Line Chart

A bar graph that is represented by circles, triangles, or crosses with lines connecting them so that it has the appearance of a line graph. (See *Line Graph.*) This is a useful representation when two or more sets of data are shown on the same graph. Example: survey results on the percentages of primary students and of intermediate students having difficulty in getting to various places in the school.

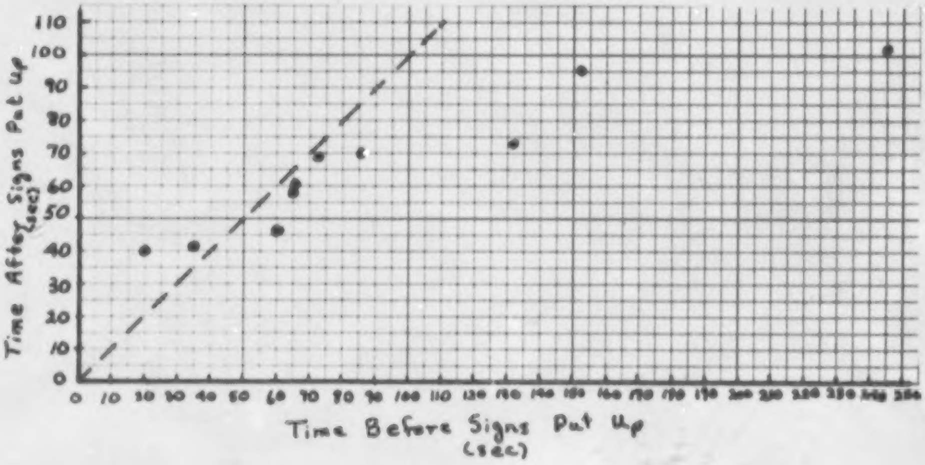
Room	Percentage of Students Having Difficulty Finding Room	
	Primary	Intermediate
Classrooms	64%	44%
Auditorium	51%	4%
Janitor's Room	50%	38%
Nurse's Room	46%	29%
Office	42%	16%
Music Room	41%	10%
Reading Room	38%	14%
Library	30%	6%
Gym	26%	6%
Cafeteria	20%	9%
Bathrooms	20%	4%
Art Room	18%	15%



Line Graph	A graph in which a smooth line or line segments pass through or near points representing members of a set of data. Since the line represents an infinity of points, the variable on the horizontal axis must be continuous. If the spaces between the markings on the horizontal axis have no meaning, then the graph is not a line graph, but a line chart (see *Line Chart*), even though the data points are connected by lines.
Q-Q Graph	A graph that shows the comparison between the same type of data collected from two groups of people,...from two different situations. Example: times students take to reach some place in the school before a change is made (e.g., directional signs) and after a change is made. The data for each set is ordered and the smallest measurement of one set is plotted against the smallest of the other set, the second smallest against the second smallest, and so on. The scatter of points is compared to a reference line, a dashed 45° line that represents the data from two identical sets.

TIME TO REACH OFFICE

Before Signs (sec)	After Signs (sec)
20	40
35	42
60	46
65	58
66	61
73	69
86	70
132	73
152	95
245	102



Inference	An assumption derived from facts or information considered to be valid and accurate.
Mean	See *Average*.
Median	The middle value of a set of data in which the elements have been ordered from smallest to largest. The median value has as many elements above it as below it.
Mode	The element or elements in a set of data that occur most often.
Ordered Set	A set of data arranged from smallest to largest.
Per Cent	Literally per hundred. A ratio in which the denominator is always 100, e.g., 72 percent = 72/100 = 0.72 = 72% , where the symbol % represents 1/100.
Percentage	A part of a whole expressed in hundredths.
Probability	The likelihood or chance (expressed numerically) of one event occurring out of several possible events.
Proportion	A statement of equality of two ratios, i.e., the first term divided by the second term equals the third term divided by the fourth term, e.g., 5/10 = 1/2. Also a synonym for ratio: when two quantities are in direct proportion, their ratios are the same.
Quartile	
First	The first quartile is the value of the quarter-way piece of data in an ordered set of data.
Third	The third quartile is the value of the three-quarter-way piece of data in an ordered set of data.
Interquartile Range	The range or length of the middle 50% of an ordered set of data; the difference between the first and third quartile.
Range	Mathematical: the difference between the smallest and the largest values in a set of data.
Rank	To order the members of a set according to some criterion, such as size or importance. Example: to put pieces of data from smallest to largest.

Ratio	The quotient of two denominate numbers or values indicating the relationship in quantity, size, or amount between two different things. For example, the ratio of the number of students who have difficulty in getting from one place to another in the school to the total number of students in the school might be $\frac{84}{279}$ or 84:279.
Sample	A representative fraction of a population studied to gain information about the whole population.
Sample Size	The number of elements in a sample.
Scale	A direct proportion between two sets of dimensions (as between the dimensions in a drawing of a lab and the actual lab.)
Scale Drawing	A drawing whose dimensions are in direct proportion to the object drawn.
Scale Map	A map whose dimensions are in direct proportion to the dimensions of the area represented.
Slope Diagram	See *Graph*.
Statistics	The science of drawing conclusions or making predictions using a collection of quantitative data.
Tally	A visible record used to keep a count of some set of data, especially a record of the number of times one or more events occur. Example: the number of students having trouble finding the library.

E. Skills, Processes, and Areas of Study Utilized in Getting There

The unique aspect of USMES is the degree to which it provides experience in the process of solving real problems. Many would agree that this aspect of learning is so important as to deserve a regular place in the school program even if it means decreasing to some extent the time spent in other important areas. Fortunately, real problem solving is also an effective way of learning many of the skills, processes, and concepts in a wide range of school subjects.

On the following pages are five charts and an extensive, illustrative list of skills, processes, and areas of study that are utilized in USMES. The charts rate Getting There according to its potential for learning in various categories of each of five subject areas--real problem solving, mathematics, science, social science, and language arts. The rating system is based on the amount that each skill, process, or area of study within the subject areas is used--extensive (1), moderate (2), some (3), little or no use (-). (The USMES Guide contains a chart that rates all USMES units in a similar way.)

The chart for real problem solving presents the many aspects of the problem-solving process that students generally use while working on an USMES challenge. A number of the steps in the process are used many times and in different orders, and many of the steps can be performed concurrently by separate groups of students. Each aspect listed in the chart applies not only to the major problem stated in the unit challenge but also to many of the tasks each small group undertakes while working on a solution to the major problem. Consequently, USMES students gain extensive experience with the problem-solving process.

The charts for mathematics, science, social science, and language arts identify the specific skills, processes, and areas of study that may be learned by students as they respond to a Getting There challenge and become involved with certain activities. Because the students initiate the activities, it is impossible to state unequivocally which activities will take place. It is possible, however, to document activities that have taken place in USMES classes and identify those skills and processes that have been used by the students.

Knowing in advance which skills and processes are likely to be utilized in Getting There and knowing the extent that they will be used, teachers can postpone the teaching of those skills in the traditional manner until later in the year. If the students have not learned them during their USMES activities by that time, they can study them in the usual way. Further, the charts enable a teacher to integrate USMES more readily with other areas of classroom work. For example, teachers may teach fractions during math period when fractions are also being learned and utilized in the students' USMES activities. Teachers who have used USMES for several successive years have found that students are more motivated to learn basic skills when they have determined a need for them in their USMES activities. During an USMES session the teacher may allow the students to learn the skills entirely on their own or from other students, or the teacher may conduct a skill session as the need for a particular skill arises.

Because different USMES units have differing emphases on the various aspects of problem solving and varying amounts of possible work in the various subject areas, teachers each year might select several possible challenges, based on their students' previous work in USMES, for their class to consider. This choice should provide students with as extensive a range of problems and as wide a variety of skills, processes, and areas of study as possible during their years in school. The charts and lists on the following pages can also help teachers with this type of planning.

Some USMES teachers have used a chart similar to the one given here for real problem solving as a record-keeping tool, noting each child's exposure to the various aspects of the process. Such a chart might be kept current by succeeding teachers and passed on as part of a student's permanent record. Each year some attempt could be made to vary a student's learning not only by introducing different types of challenges but also by altering the specific activities in which each student takes part. For example, children who have done mostly construction work in one unit may be encouraged to take part in the data collection and data analysis in their next unit.

Following the rating charts are the lists of explicit examples of real problem solving and other subject area skills, processes, and areas of study learned and utilized in Getting There. Like the charts, these lists are based on documentation of activities that have taken place in USMES classes. The greater detail of the lists allows teachers to see exactly how the various basic skills, processes, and areas of study listed in the charts may arise in Getting There.

The number of examples in the real problem solving list have been limited because the list itself would be unreasonably long if all the examples were listed for some of the categories. It should also be noted that the example(s) in the first category--*Identifying and Defining Problems*--have been limited to the major problem that is the focus of the unit. During the course of their work, the students will encounter and solve many other, secondary problems, such as the problem of how to display their data or how to draw a scale layout.

Breaking down an interdisciplinary curriculum like USMES into its various subject area components is a difficult and highly inexact procedure. Within USMES the various subject areas overlap significantly, and any subdivision must be to some extent arbitrary. For example, where does measuring as a mathematical skill end and measurement as science and social science process begin? How does one distinguish between the processes of real problem solving, of science, and of social science? Even within one subject area, the problem still remains--what is the difference between graphing as a skill and graphing as an area of study? This problem has been partially solved by judicious choice of examples and extensive cross-referencing.

Because of this overlap of subject areas, there are clearly other outlines that are equally valid. The scheme presented here was developed with much care and thought by members of the USMES staff with help from others knowledgeable in the fields of mathematics, science, social science, and language arts. It represents one method of examining comprehensively the scope of USMES and in no way denies the existence of other methods.

REAL PROBLEM SOLVING	Overall Rating
Identifying and defining problem.	1
Deciding on information and investigations needed.	1
Determining what needs to be done first, setting priorities.	2
Deciding on best ways to obtain information needed.	1
Working cooperatively in groups on tasks.	1
Making decisions as needed.	1
Utilizing and appreciating basic skills and processes.	1
Carrying out data collection procedures--observing, surveying, researching, measuring, classifying, experimenting, constructing.	1
Asking questions, inferring.	1
Distinguishing fact from opinion, relevant from irrelevant data, reliable from unreliable sources.	1

REAL PROBLEM SOLVING	Overall Rating
Evaluating procedures used for data collection and analysis. Detecting flaws in process or errors in data.	1
Organizing and processing data or information.	1
Analyzing and interpreting data or information.	1
Predicting, formulating hypotheses, suggesting possible solutions based on data collected.	1
Evaluating proposed solutions in terms of practicality, social values, efficacy, aesthetic values.	1
Trying out various solutions and evaluating the results, testing hypotheses.	1
Communicating and displaying data or information.	1
Working to implement solution(s) chosen by the class.	1
Making generalizations that might hold true under similar circumstances; applying problem-solving process to other real problems.	1

KEY: 1 = extensive use, 2 = moderate use, 3 = some use, - = little or no use

MATHEMATICS	Overall Rating
Basic Skills	
Classifying/Categorizing	3
Counting	1
Computation Using Operations	
Addition/Subtraction	1
Multiplication/Division	1
Fractions/Ratios/Percentages	1
Business and Consumer Mathematics/ Money and Finance	2
Measuring	1
Comparing	3
Estimating/Approximating/Rounding Off	1
Organizing Data	1
Statistical Analysis	1
Opinion Surveys/Sampling Techniques	3
Graphing	2
Spatial Visualization/Geometry	2
Areas of Study	
Numeration Systems	2
Number Systems and Properties	1
Denominate Numbers/Dimensions	1
Scaling	2
Symmetry/Similarity/Congruence	-
Accuracy/Measurement Error/ Estimation/Approximation	1
Statistics/Random Processes/Probability	1
Graphing/Functions	2
Fraction/Ratio	1
Maximum and Minimum Values	3
Equivalence/Inequality/Equations	3
Money/Finance	2
Set Theory	-

SCIENCE	Overall Rating
Processes	
Observing/Describing	1
Classifying	2
Identifying Variables	2
Defining Variables Operationally	2
Manipulating, Controlling Variables/ Experimenting	2
Designing and Constructing Measuring Devices and Equipment	2
Inferring/Predicting/Formulating, Testing Hypotheses/Modeling	1
Measuring/Collecting, Recording Data	1
Organizing, Processing Data	1
Analyzing, Interpreting Data	1
Communicating, Displaying Data	1
Generalizing/Applying Process to New Problems	1
Areas of Study	
Measurement	1
Motion	2
Force	-
Mechanical Work and Energy	-
Solids, Liquids, and Gases	-
Electricity	-
Heat	-
Light	-
Sound	-
Animal and Plant Classification	-
Ecology/Environment	-
Nutrition/Growth	-
Genetics/Heredity/Propagation	-
Animal and Plant Behavior	-
Anatomy/Physiology	-

KEY: 1 = extensive use, 2 = moderate use, 3 = some use, - = little or no use

SOCIAL SCIENCE	Overall Rating
Process	
Observing/Describing/Classifying	2
Identifying Problems, Variables	1
Manipulating, Controlling Variables/ Experimenting	2
Inferring/Predicting/Formulating, Testing Hypotheses	1
Collecting, Recording Data/Measuring	2
Organizing, Processing Data	2
Analyzing, Interpreting Data	2
Communicating, Displaying Data	2
Generalizing/Applying Process to Daily Life	1
Attitudes/Values	
Accepting responsibility for actions and results	1
Developing interest and involvement in human affairs	1
Recognizing the importance of individual and group contributions to society	1
Developing inquisitiveness, self-reliance, and initiative	1
Recognizing the values of cooperation, group work, and division of labor	1
Understanding modes of inquiry used in the sciences, appreciating their power and precision	1
Respecting the views, thoughts, and feelings of others	1
Being open to new ideas and information	1
Learning the importance and influence of values in decision making	1
Areas of Study	
Anthropology	-
Economics	2
Geography/Physical Environment	2
Political Science/Government Systems	3
Recent Local History	-
Social Psychology/Individual and Group Behavior	-
Sociology/Social Systems	3

LANGUAGE ARTS	Overall Rating
Basic Skills	
Reading	
Literal Comprehension: Decoding Words, Sentences, Paragraphs	1
Critical Reading: Comprehending Meanings, Interpretation	1
Oral Language	
Speaking	1
Listening	1
Memorizing	-
Written Language	
Spelling	1
Grammar: Punctuation, Syntax, Usage	1
Composition	1
Study Skills	
Outlining/Organizing	1
Using References and Resources	1
Attitudes/Values	
Appreciating the value of expressing ideas through speaking and writing	1
Appreciating the value of written resources	1
Developing an interest in reading and writing	1
Making judgments concerning what is read	1
Appreciating the value of different forms of writing, different forms of communication	1

KEY: 1 = extensive use, 2 = moderate use,
3 = some use, - = little or no use

REAL PROBLEM SOLVING IN GETTING THERE

Identifying and Defining Problems	• Students decide to help themselves, students, and school visitors by making it easier for them to locate places in the school. • See SOCIAL SCIENCE list: *Identifying Problems, Variables.*
Deciding on Information and Investigations Needed	• After a discussion students decide they need to survey students to find out whether they have trouble getting places and to find out which places are difficult to find or to reach. • Students decide that directional signs and maps will inform many people (students, visitors) about the locations of places in the school. • Students decide that they need to find out whether the signs and maps help people find their way to certain places. They agree to conduct timed trial runs from one location to another so that times after improvement (maps, signs, etc.) can be compared with times before improvement.
Determining What Needs to be Done First, Setting Priorities	• Children decide to conduct opinion survey before making signs so that they will know where signs are needed the most. • Children decide to measure hall and room dimensions in the school for a scale map. • Children decide time trials need to be done before putting up directional signs and again after signs are put up.
Deciding on Best Ways to Obtain Information Needed	• Students conduct survey to obtain student opinion on difficulties in getting around. • Students decide to measure school with tape measures and trundle wheels. • Students decide to use stopwatch and time several students as they attempt to find various locations, starting from school entrances.
Working Cooperatively in Groups on Tasks	• Students form groups to conduct survey, to take building measurements, to conduct time trials, to draw scale map of school.

Making Decisions as Needed	• Students decide to work in groups so that more can be accomplished. • Students decide to survey a sample of students from each grade. • Students decide to construct directional signs and draw scale maps as part of their solution. • Students decide to conduct "Before" and "After" time trials.
Utilizing and Appreciating Basic Skills and Processes	• Students interpret results of survey to find locations that students find most difficult to reach. • Students measure classrooms, hallways, and other parts of the school for scale map. • Students time several students as they try to locate various rooms in the school. • Students give oral presentation to principal to obtain permission to make changes. • See also MATHEMATICS, SCIENCE, SOCIAL SCIENCE, and LANGUAGE ARTS lists.
Carrying Out Data Collection Procedures--Opinion Surveying, Researching, Measuring, Classifying, Experimenting, Constructing	• Students conduct opinion survey. • Students look up school floor plan. • Students conduct time trials. • Students classify locations in school according to function. • Students make directional signs, trundle wheel. • See also MATHEMATICS list: *Classifying/Categorizing; Measuring; Opinion Surveys/Sampling Techniques.* • See also SCIENCE list: *Observing/Describing; Classifying; Manipulating, Controlling Variables/Experimenting; Designing and Constructing Measuring Devices and Equipment; Measuring/Collecting, Recording Data.* • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying; Manipulating, Controlling Variables/Experimenting; Collecting, Recording Data/Measuring.*
Asking Questions, Inferring	• Students ask whether students have problems getting places and infer from interviews and surveys that they do. • Students infer that the results from a sample of students reflect the views of all the students. • Students infer from the results of surveys and time trials that their changes (signs, maps, etc.) have helped.

Asking Questions, Inferring (cont.)	• Students infer from comparing before and after times that several of their solutions do make it easier for people to find places in the school. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.* • See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Distinguishing Fact from Opinion, Relevant from Irrelevant Data, Reliable from Unreliable Sources	• Students recognice the qualitative aspects of obtaining data from an opinion survey. • Students recognize that the times various students take to reach several locations are important data for their investigations. • Students recognize that their own measurements are a reliable source of information about the school layout.
Evaluating Procedures Used for Data Collection and Analysis, Detecting Flaws in Process or Errors in Data	• Students decide to improve their opinion survey and discuss changes to be made so that their questions are clear and easy to understand and so that they will obtain the information they want. • Students discuss methods used to measure for scale map of school and discuss any discrepancies. Students choose a tape measure as being most accurate for final measurements. • Students discuss methods to be used in conducting time trials. They agree that students unfamiliar with the routes should be timed from the same entrance to the same final destination. • See also MATHEMATICS list: *Estimating/Approximating/Rounding Off.*
Organizing and Processing Data	• Ordering results of opinion survey. • Tabulating measurements of school building. • Recording and tabulating results of time trials. • See MATHEMATICS list: *Organizing Data.* • See also SCIENCE and SOCIAL SCIENCE lists: *Organizing, Processing Data.*
Analyzing and Interpreting Data	• Interpreting results of opinion survey; drawing bar graph of results. • Comparing before and after times (or average time for each location) in time trials; interpreting results to determine efficacy of each proposed solution.

Analyzing and Interpreting Data (cont.)	• See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques.* • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data.*
Predicting, Formulating Hypotheses, Suggesting Possible Solutions Based on Data Collected	• Students hypothesize that directional signs and maps will help students to get around the school. • After conducting survey, students recommend signs that show the way to several locations in the school. • Students hypothesize that conducting time trials before and after changes (signs, maps, etc.) will tell them how effective their solutions are. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.* • See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Trying Out Various Solutions and Evaluating the Results, Testing Hypotheses	• Students decide from comparison of before and after times from time trials that the directional signs were very effective. • Based on student response (in a survey) to their changes, students decide their improvements were needed. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.* • See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Communicating and Displaying Data or Information	• Students tabulate and graph times from time trials; students compare before and after times by drawing a Q-Q graph. • See also MATHEMATICS list: *Graphing; Scaling.* • See also SCIENCE and SOCIAL SCIENCE lists: *Communicating, Displaying Data.* • See also LANGUAGE ARTS list.
Working to Implement Solution(s) Chosen by the Class	• Students prepare and install directional signs. • Students prepare scale map of school.
Making Generalizations That Might Hold True Under Similar Circumstances; Applying Problem Solving Process to Other Real Problems	• Students apply knowledge and skills acquired to finding their way about the community or other areas; students develop self-confidence about dealing with new or unfamiliar locations.

Making Generalizations That Might Hold True Under Similar Circumstances; Applying Problem Solving Process to Other Real Problems (cont.)	● See also SCIENCE list: *Generalizing/Applying Process to New Problems.* ● See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life.*

ACTIVITIES IN GETTING THERE UTILIZING MATHEMATICS

Basic Skills

Classifying/Categorizing	• Using the concepts and language of sets (subsets, unions, intersections, set notation), e.g., set of students, teachers, parents. • Organizing and classifying sets of materials, information, or activities, e.g., materials for signs. • See also SCIENCE list: *Classifying.* • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying.*
Counting	• Counting votes to set priorities and determine action to be taken. • Counting survey data, such as questionnaire data on problems faced by students on getting around the school or community. • Counting number of seconds, number of meters, number of people. • Counting to read scales on measuring instruments, such as tape measures or meter sticks. • Counting by sets to find scale for graph axes.
Computation Using Operations: Addition/Subtractions	• Adding one-, two-, or three-digit whole numbers to find total tally or total measurement, such as the size of a classroom or hallway for a scale drawing. • Adding minutes and seconds when timing students getting from one place to another following a predetermined route; subtracting minutes and seconds to compare before and after times. • Subtracting to find differences between predicted and actual measurements, e.g., the number of people who have difficulty getting around the school or community. • Subtracting one-, two-, or three-digit whole numbers to find ranges for graph axes or for measurement data.
Computation Using Operations: Multiplication/Division	• Using multiplication and division to increase or decrease measurements, e.g., for scale drawings. • Multiplying whole numbers to find total measurement. • Multiplying or dividing to find scale for graph axes. • Multiplying and dividing to convert from feet to inches and vice versa.

Computation Using Operations: Multiplication/Division (cont.)	• Dividing minutes and seconds to calculate averages, e.g., average travel time to get from one location to another. • Dividing to calculate ratios, fractions, or percentages while tabulating data, e.g., percentage of students who have difficulty getting from one place to another.
Computation Using Operations: Ratios/Fractions/Percentages	• Using mixed numbers to perform calculations, such as determining measurements of a room. • Using ratios and fractions to convert from inches to yards, centimeters to meters. • Using ratios to increase or decrease measurements, e.g., for scale drawings of school. • Using fractions in measurement, graphing, graphing comparisons, scale drawings. • Calculating ratios or percentages from test or survey data.
Computation Using Operations: Business and Consumer Mathematics/ Money and Finance	• Adding, subtracting, multiplying, and dividing dollars and cents to perform cost analysis, e.g., on costs of materials for signs and maps, of public transportation to get to places in the community. • Gaining experience with finance: sources, uses, and limitations of revenue.
Measuring	• Using arbitrary units (e.g., children's feet) to measure the distance to a certain place. • Using different standard units of measure, e.g., to measure the distance to a certain place, to measure length and width of signs. • Using different measuring tools. • Reading measuring devices, such as a meter stick or trundle wheel, accurately. • Converting from one unit of measurement to another, e.g., inches to feet, centimeters to meters. • See also SCIENCE list: *Measuring/Collecting, Recording Data.* • See also SOCIAL SCIENCE list: *Collecting, Recording Data/Measuring.*

Estimating/Approximating/ Rounding Off	• Estimating error in qualitative judgments when collecting survey data. • Estimating the distance to a certain place or the time it will take to get there. • Determining when a measurement is likely to be accurate enough for a particular purpose. • Rounding off measurements while measuring hallways, rooms, etc. • Rounding off measurements while drawing scale map of a given area.
Organizing Data	• Tallying votes to set priorities. • Tallying survey data. • Tallying on bar graphs, such as the number of students in each class that have difficulty getting to various places in the school. • Ordering real numbers on number line or graph axis. • Ordering test or survey results, such as places most difficult to find. • Ordering inches, feet, and yards or centimeters and meters when making a scale drawing of the school. • See also SCIENCE and SOCIAL SCIENCE lists: *Organizing, Processing Data*.
Statistical Analysis	• Assessing predictability of larger sample based on results from smaller sample. • Finding and comparing medians and modes of survey and measurement data, e.g., median time to get to some place in the school. • Determining range of a set of data. • Compiling quantitative data--survey results, measurements, etc. • Interpreting bar graphs, histograms, q-q graphs. • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data*.
Opinion Surveys/Sampling Techniques	• Conducting surveys; defining data collection methods, makeup and size of sample. • Devising methods of obtaining quantitative information about subjective opinions on problems of getting around the school or community. • Evaluating survey methodology, data obtained, size and type of samples.

Graphing	• Using alternative methods of displaying survey data. • Making a graph form--dividing axes into parts, deciding on an appropriate scale. • Representing data on graphs: • Bar graph--the number of students who have difficulty getting to various places in the school. • Conversion graph--to convert from meters to spaces on graph paper for mapping the school. • Cumulative frequency graph--the number of students who take a certain amount of time or less to get to a predetermined location. • Histogram--the number of students who walked a certain distance in a given time. • Line chart--the time it takes to get to a certain place vs. grade level (primary, intermediate). • Q-Q graph--times of several students to reach a predetermined location before and after signs have been installed. • Slope diagram--yes votes vs. total votes for several survey questions. • Obtaining information from graphs.
Spatial Visualization/Geometry	• Constructing and using geometric figures, for example, triangles, circles, etc., for directional signs and room signs. • Using geometric figures to understand and utilize relationships, such as perimeter, area, volume, similarity, congruence. • Measuring and constructing using rulers, compasses, and protractors. • Using spatial arrangements to convey information, for example, scale drawings. • Using the concept of "greater than" and "less than" to compare geometric figures.
Areas of Study	
Numeration Systems	• Using decimal system in measuring length (cm, m), in determining costs (collars, cents). • Using fractions in measuring.
Number Systems and Properties	• See *Computation Using Operations*.
Denominate Numbers/Dimensions	• See *Measuring*.

Scaling	● Finding an appropriate scale for a scale map or scale drawing. ● Using a scale to draw and make representations in a scale drawing. ● Deriving information from scale drawings and maps. ● Making maps of school or nearby areas.
Symmetry/Similarity/Congruence	● See *Spatial Visualization/Geometry.*
Accuracy/Measurement Error/ Estimation/Approximation	● See *Measuring* and *Estimating/Approximating/Rounding Off.*
Statistics/Random Processes/ Probability	● See *Statistical Analysis.*
Graphing/Functions	● See *Graphing.*
Fraction/Ratio	● See *Computation Using Operations: Fractions/Ratios/ Percentages.*
Maximum and Minimum Values	● Finding the shortest way (in time, in distance) to get to a predetermined location. ● Determining from opinion surveys places that are hard to find.
Equivalence/Inequality/Equations	● See *Comparing* and *Computation Using Operations.*
Money/Finance	● See *Computation Using Operations: Business and Consumer Mathematics/Money and Finance.*
Set Theory	● See *Classifying/Categorizing.*

ACTIVITIES IN GETTING THERE UTILIZING SCIENCE

Process	
Observing/Describing	• Observing and describing the physical layout of the school building and grounds. • Observing and describing time trials of students going from one location to a predetermined destination. • See also SOCIAL SCIENCE list: *Observing/Describing/ Classifying.*
Classifying	• Classifying directional signs according to proposed size, shape, color, usage. • Classifying times to get places as slow, average, or fast. • Classifying places in the school in terms of difficulty in finding them. • Classifying various ways of getting to a given place. • See also MATHEMATICS list: *Classifying/Categorizing.* • See also SOCIAL SCIENCE list: *Observing/Describing/ Classifying.*
Identifying Variables	• Identifying width and length of rooms, hallways, lunchroom, gym, etc., as things to be measured for making a scale drawing of the school layout. • Identifying distance (length) as a variable to be measured to determine the best way to get somewhere. • Identifying time as a variable to be measured to determine the best way to get somewhere. • Identifying distance and time of day as variables to be held constant while measuring times of several students. • Identifying length and width as measurements needed to construct directional signs, maps, etc. • See also SOCIAL SCIENCE list: *Identifying Problems, Variables.*
Defining Variables Operationally	• Defining distance, length, and width (of route to a specific place, rooms, hallways, etc.) as that obtained by measuring with a meter stick (trundle wheel, tape measure, etc.). • Defining time as that measured by a stopwatch from a student's start until his/her arrival at the place being sought.

Defining Variables Operationally (cont.)	• Defining length and width of signs as that obtained by measuring with a ruler or a meter stick.
Manipulating, Controlling Variables/ Experimenting	• Timing a sample of students as they attempt to find the same predetermined location at the same time of day (thereby holding the distance and time of day constant). • Comparing different solutions (e.g., directional signs, maps, room numbering) by timing for each solution a sample of students after improvements have been made and comparing the data with that from the trial runs before improvements were made. • See also SOCIAL SCIENCE list: *Manipulating, Controlling Variables/Experimenting.*
Designing and Constructing Measuring Devices and Equipment	• Designing and constructing signs to direct people to various places around the school.
Inferring/Predicting/Formulating, Testing Hypotheses/Modeling	• Predicting that directional signs will help people find places; inferring from data collected on times that they do. • Hypothesizing that measurements taken with a trundle wheel (tape measure, meter stick, etc.) will be accurate enough for a scale map of the school; drawing a map and finding that they are. • Hypothesizing that the shortest distance from one place to another is the fastest way to go; finding from trial runs that this is so. • Making a scale map of school building showing best routes to certain places. • See also SOCIAL SCIENCE list: *Inferring/Predicting/ Formulating, Testing Hypotheses.*
Measuring/Collecting, Recording Data	• Using a stopwatch to time students as they go from one place to another predetermined location; recording the times on a chart. • Measuring distances to places in school. • Measuring hallways and rooms for scale map. • Measuring while constructing signs, map racks, etc. • See also MATHEMATICS list: *Measuring.* • See also SOCIAL SCIENCE list: *Collecting, Recording Data/Measuring.*

Organizing, Processing Data	• Tabulating times collected during time trials of students finding various places. • Tabulating measurements of school building (hallways, rooms, etc.) before drawing scale map. • See also MATHEMATICS list: *Organizing Data.* • See also SOCIAL SCIENCE list: *Organizing, Processing Data.*
Analyzing, Interpreting Data	• Interpreting charts and/or graphs to find shortest times to determine best way of getting to a given location. • Comparing before and after times to determine efficacy of various improvements (directional signs, maps, etc.). • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques; Graphing; Maximum and Minimum Values.* • See also SOCIAL SCIENCE list: *Analyzing, Interpreting Data.*
Communicating, Displaying Data	• Drawing graphs or making charts to communicate data. • Drawing maps to show people where places are. • See also MATHEMATICS list: *Graphing.* • See also SOCIAL SCIENCE list: *Communicating, Displaying Data.*
Generalizing/Applying Process to New Problems	• Using knowledge acquired to solve other problems, such as getting from place to place more easily in the school or community. • See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life.*
Areas of Study	
Measurement	• Timing students on trial runs from one location to another predetermined location. • Observing and understanding differences between minutes and seconds, between meters and centimeters. • Measuring with meter sticks, trundle wheels, tape measures, etc.

Motion	
Speed/Velocity	• Observing that the time to get to a given place is speed; observing that the shortest time to go a given distance implies the greatest speed. • Observing that electrically-run machines (saber saws, duplicating machines) are faster than hand machines.
Force	• Observing that electrically-run machines require less effort to operate than hand machines and multiply the force they exert. • Observing that force must be applied to hammer nails into wood; observing that a hammer multiplies the force that can be exerted. • Observing that force must be exerted to operate a stapler.
Mechanical Work and Energy	• Observing the difference in energy required to climb stairs vs. walking on a level surface. • Noting that work is done and energy expended when nails are hammered into wood, when Tri-Wall is cut. • Observing that electrical energy is transformed into the mechanical energy of saber saws, electric drills. • See also *Motion* and *Force*.
Solids, Liquids, and Gases	
States of Matter	• Observing that glue is available in liquid or solid form, each having different properties. • Observing that a solid stick of glue is turned into a hot, liquid glue by using heat from a hot glue gun.
Properties of Matter	• Observing that different construction materials, such as lumber and Tri-Wall, have different properties that make them useful for different tasks. • Observing that various materials available have different densities and colors, e.g., paper or posterboard for making directional or room signs.
Electricity	• Observing that electrical energy can be transformed into mechanical energy (electrical tools) and into heat energy (hot glue gun).

Light

- Observing that signs and posters are more easily read in well-lighted areas because objects become visible as light is reflected from them into the eye.
- Observing that signs, posters, and other written messages may be difficult to read if both the writing and background are similar in color but may be more easily read if the colors are contrasting.
- Observing that paints, crayons, papers, posterboard come in various colors because different objects reflect certain colors in the spectrum and absorb the rest--the color of an object is determined by the color it reflects.

ACTIVITIES IN GETTING THERE UTILIZING SOCIAL SCIENCE

Process	
Observing/Describing/Classifying	• Observing, describing, and classifying difficulties that students have in getting from place to place (in the school or community). • Organizing and classifying sets of ideas or information. • Classifying groups of people according to similarities (e.g., grade level) in order to choose a stratified sample for an opinion survey. • Describing results of surveys. • See also MATHEMATICS list: *Classifying/Categorizing.* • See also SCIENCE list: *Observing/Describing; Classifying.*
Identifying Problems, Variables	• Identifying problems students have in getting around; identifying problem locations (those that are particularly difficult to find or reach). • Identifying variables that affect the results of an opinion survey, such as age, grade level, habits, background, time of day. • Identifying variables that may affect a person's ability to find various locations, such as age, grade level, background. • Identifying variables that may affect results of time trials, such as prior knowledge, age, grade level. • See also SCIENCE list: *Identifying Variables.*
Manipulating, Controlling Variables/ Experimenting	• Conducting trial runs (both with and without improvements) using groups of students that are unfamiliar with the school so that prior knowledge of locations is eliminated; using different groups in the before and after trials for the same reason. • Designing and conducting an opinion survey on problems that students have in getting places using a stratified sample; controlling other variables; keeping results for various groups separate. • See also SCIENCE list: *Manipulating, Controlling Variables/Experimenting.*
Inferring/Predicting/Formulating, Testing Hypotheses	• Inferring from the results of an opinion survey that many students have difficulty in getting from place to place in the school or community.

Inferring/Predicting/Formulating, Testing Hypotheses (cont.)	• Inferring that the survey results from a sample of students reflect the concerns of all the students in that population (e.g., all students, all fifth graders). • Hypothesizing that directional signs (room signs, room numbers, maps, etc.) will help people find their way around the school; conducting time trials to determine whether this is so. • Inferring from comparison of time trial results that directional signs (room signs, maps, etc.) are the best solution. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.*
Collecting, Recording Data/ Measuring	• Recording results of opinion surveys on locations that are difficult to reach or find; indicating age, grade level(s) of group(s) surveyed. • See also MATHEMATICS list: *Counting; Measuring.* • See also SCIENCE list: *Measuring/Collecting, Recording Data.*
Analyzing, Interpreting Data	• Interpreting results, including graphs, of survey data to find locations that students find most difficult to find or reach. • Comparing data from different groups in opinion survey. • Evaluating the way the opinion survey was administered, the size and makeup of the sample. • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys; Sampling Techniques; Graphing.* • See also SCIENCE list: *Analyzing, Interpreting Data.*
Communicating, Displaying Data	• Making signs, charts, or maps that can be easily understood by all students. • Representing survey data on bar graphs. • See also MATHEMATICS list: *Graphing.* • See also SCIENCE list: *Communicating, Displaying Data.*
Generalizing/Applying Process to Daily Life	• Applying knowledge acquired to solve similar problems of getting around the community or other areas. • See also SCIENCE list: *Generalizing/Applying Process to New Problems.*

Attitudes/Values

Accepting Responsibility for Actions and Results	• Making sure that various tasks (e.g., conducting survey, obtaining necessary permissions, taking measurements, conducting time trials, drawing maps) are done. • Arranging schedules for conducting survey. • Scheduling and giving presentation to principal for permission to conduct trials and to install directional signs (map racks, room numbers, room signs, etc.). • Being responsible for actions while out of the classroom.
Developing Interest and Involvement in Human Affairs	• Informing students about the locations of various rooms. • Informing students about getting around the community (e.g., by public transportation).
Recognizing the Importance of Individual and Group Contributions to Society	• Recognizing that their efforts will help all students that have difficulty in finding or reaching various locations in the school or community.
Developing Inquisitiveness, Self-Reliance, and Initiative	• Conducting small and large group sessions with help from the teacher. • Dealing with other teachers and students to conduct surveys, to conduct time trials. • Dealing with principal to obtain permission to implement solutions. • Finding own solutions to problems encountered. • Developing different ways to convey information, e.g., maps, directional signs, room numbers, room signs.
Recognizing the Values of Cooperation, Group Work, and Division of Labor	• Finding that work progresses more rapidly when different groups work on different aspects of the problem or on different solutions. • Finding that work progresses more smoothly when everyone cooperates.
Understanding Modes of Inquiry Used in the Sciences, Appreciating Their Power and Precision	• Identifying locations that are difficult to find or reach; developing ways to remedy the situation. • Recognizing the importance of obtaining information from the group of persons affected. • Convincing the principal that the program they are proposing (e.g., directional signs, maps, room signs,

Understanding Modes of Inquiry Used in the Sciences, Appreciating Their Power and Precision (cont.)	room numbers) is useful and necessary through the use of supporting survey and time trial data. • See also MATHEMATICS and SCIENCE lists.
Respecting the Views, Thoughts, and Feelings of Others	• Considering all suggestions from members of group and assessing their merit. • Conducting opinion survey to determine locations that others find difficult to locate or reach. • Recognizing that people's opinions vary.
Being Open to New Ideas and Information	• Considering other ways of doing various tasks. • Asking other members of the class (other teachers, other students, principal) for ideas and suggestions.
Learning the Importance and Influence of Values in Decision Making	• Recognizing that different students or groups of students may have differing needs for specific information and that different solutions may be required for different groups. • Recognizing that different people have different opinions as to the difficulty of reaching various locations.

Areas of Study

Economics	• Assessing costs of proposed solutions. • Investigating costs of various forms of public transportation for use in getting around community (e.g., bus routes, subway routes, bike paths). • Gaining experience with finance: sources, uses, and limitations of revenues.
Geography/Physical Environment	• Making and using maps of the school, local community, transportation systems. • Investigating and changing school physical environment by making it easier for students to get around.
Political Science/Government Systems	• Investigating systems of administration and control; deciphering the role of the governing body over the body that is governed, e.g., dealing with school authorities to schedule surveys, time trials, implementation of solutions.

Political Science/Government Systems (cont.)	• Determining need for rules and regulations, e.g., one-way stairways, "stay to the right" signs. • Investigating regulations and policies affecting a planned course of action.
Social Psychology/Individual and Group Behavior	• Recognizing the need for leadership within small and large groups; recognizing differing capacities of individuals for various roles within groups. • Analyzing the effects of a small group making decisions for a larger group.
Sociology/Social Systems	• Considering the integral, related nature of the school or community and its physical or recreational surroundings as a factor in the problems of getting from place to place. • Devising a system for working cooperatively in small and large groups. • Investigating differing needs of different social groups, such as different grade levels. • Investigating problems and making changes that affect not only themselves, but society (other students in the school). • Working within established social systems to promote changes. • Assessing the effects of group action on helping others to get from one place to another in the school or community. • Recognizing peer groups as social systems. • Recognizing that there are many different social groups and that one person belongs to more than one social group.

ACTIVITIES IN GETTING THERE UTILIZING LANGUAGE ARTS

Basic Skills

Reading: Literal Comprehension--Decoding Words, Sentences, and Paragraphs	• Decoding words, sentences, and paragraphs while reading drafts of notes and surveys, posters and signs, informational materials on local community (transit systems, recreational areas, etc.).
Reading: Critical Reading--Comprehending Meanings, Interpretation	• Reading and evaluating drafts of notes, surveys, directions, posters. • Understanding and interpreting surveys, notes, directions, transit system maps and information.
Oral Language: Speaking	• Reporting to class on group activities; responding to criticisms of activities. • Offering ideas, suggestions, and criticisms during discussions in small group work and during class discussions on problem and proposed solutions. • Conducting opinion surveys on places that are difficult to find or to reach. • Preparing and giving effective oral presentation to principal about problems and proposed solutions, to classes taking survey. • Using the telephone properly and effectively. • Using rules of grammar in speaking.
Oral Language: Listening	• Listening to group reports. • Following spoken directions.
Written Language: Spelling	• Using correct spelling in writing.
Written Language: Grammar--Punctuation, Syntax, Usage	• Using rules of grammar in writing.

Written Language: Composition	• Writing to communicate effectively: • preparing notes and letters to teachers, parents, and students. • writing opinion survey, devising questions to elicit desired information; judging whether a question is clear. • preparing maps and directions, signs.
Study Skills: Outlining/Organizing	• Taking notes. • Developing opinion survey; ordering questions. • Planning, preparing, and scheduling presentation to principal. • Organizing facts and data in proposing various solutions.
Study Skills: Using References and Resources	• Referring to architectural blueprints of school building. • Using library and references to obtain information on transit system, local community area maps. • Using "How To" Cards for information on designing and conducting a survey, graphing, etc.

Attitudes/Values

Appreciating the Value of Expressing Ideas Through Speaking and Writing	• Finding that a written letter or note evokes a response from people--other students, parents, the principal, other teachers. • Finding that many students (and parents) can be informed about the location of places in the school through signs, maps, directions.
Appreciating the Value of Written Resources	• Finding that certain desired information can be found in written resources, e.g., lists of students, descriptions of local community and its resources (as from chambers of commerce or park and recreation departments), descriptions and schedules of transit systems. • Finding that written notes are helpful when presenting ideas to principal.
Developing an Interest in Reading and Writing	• Willingly looking up required information on school building, on local community, on transit systems. • Showing desire to work on letters, reports, maps, directions.

Making Judgments Concerning What is Read	• Deciding how reliable the information is. • Deciding whether drafts of letters, notes, survey questions say what they are supposed to say, whether they are appropriate, whether they are clear, whether they need improvement.
Appreciating the Value of Different Forms of Writing, Different Forms of Communication	• Finding that how information can be best conveyed is determined in part by the audience to whom it is directed. • Finding that certain information or data can be best conveyed in writing, preparing charts or graphs, drawing maps, etc. • Finding that certain information should be written down so that it can be referred to at a later time. • Finding that spoken instructions are sometimes better than written instructions, and vice versa.